Session 7 : Geophysical Trends Derived from 12 years of AIRS Infrared Radiances

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1 AIRS instrument

- AIRS: Grating spectrometer sounder on EOS-AQUA, 2378 channels with spectral resolution ~0.5-2.0 cm^{-1} from 650-2665 cm^{-1}. 1:30 am/pm orbit. AIRS operational for 13+ years, intensively validated.
- AIRS mission length entering climate scales
- AIRS stability: ~ 0.002 K/year (from CO_2, SST as truth)
- Clear path to connect CrIS to AIRS radiometrically (for long term climate studies)
- Climate products need error traceability
- Climate products need to be reproduced by others

2 Approach to Climate Level Products

- Decrease data volume: Random subset
- Average data (L1b gridding and binning)
- This leads to constant reprocessing by anyone!
- Adopt OEM framework with scattering RTA
- Decrease sensitivity to unknown variables by producing L3 trends and anomalies from time derivatives of L1 radiances.
- *This is not a replacement for 3x3 or single-FOV retrievals.*

This Work: A First Look

- No radiance binning, average it all.
- Examine error characteristics
- Examine ability to do anomaly retrievals
- It takes a few minutes or so to create L3 trend and anomaly retrievals for the whole mission!

3 Data Set

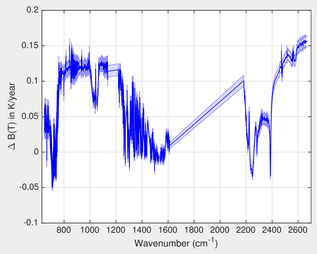
- AIRS V7 random data (implemented by UMBC)
- ~ 1-2% of data, using only 3x3 FORs next to nadir
- Zonal averages (for now): 40 equal area latitude bins
- Each channel time series fit de-seasonalized by bi-weekly average, after which linear rate and anomaly found.
- Matched to ERA for each scene (FOV) (for SARTA TwoSlab Cloud Calcs)
- No L1c or frequency corrections!

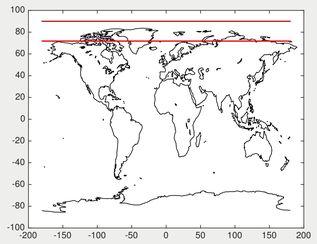
Data Set Sizes

Days	Latitudes	Channels	Variables
4480	40	2378	B(ν,T) observed
			B(ν,T) ERA All-Sky
			B(ν,T) ERA Clear

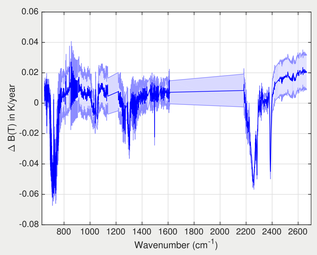
Anomalies generally quite Gaussian except for poles.

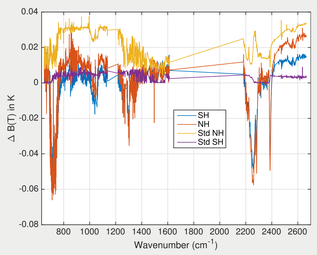
4. Example Zonal All-Sky Rates: North Polar





5. (L) Global and (R) Hemispherical Rates

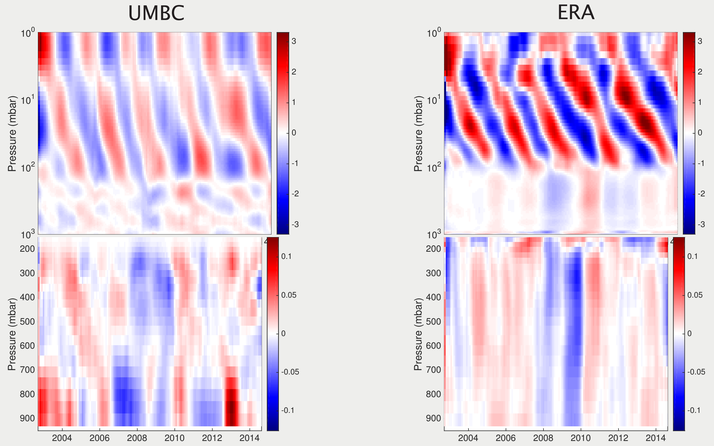




- CO_2, N_2O and CH_4 increases dominant.
- 0.01K/year in window region, 2-σ error detection
- Maybe slightly less water.
- N. and S. Hemisphere rates very similar! (land masses quite different)
- *Did not get* similar ERA rates (using cloud fields) .. cloud problems?

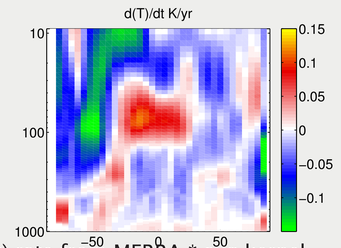
6. Example Temp (top) and Water (bottom) Anomaly -3 S to 0 S

- Climate community mostly interested in trends (and) Anomalies
- Single jacobians still used for a linear retrieval
- Anomalies ≫ rates. Linear retrieval OK (except ENSO??)

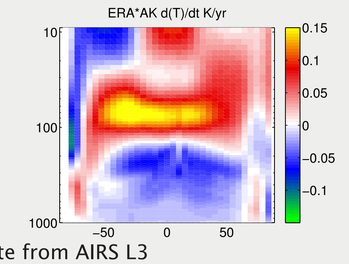


7. T(z) and WV(z) All-Sky rate retrievals

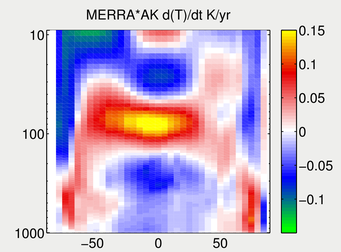
T(z) rate from UMBC-AIRS



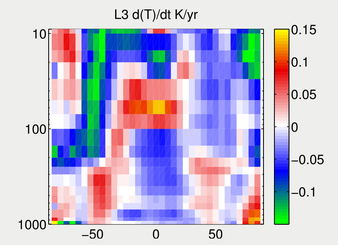
T(z) rate from ERA * avg kernel



T(z) rate from MERRA * avg kernel

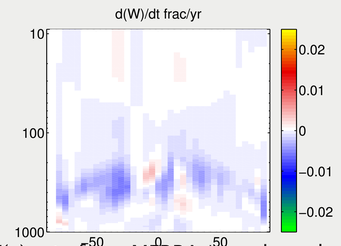


T(z) rate from AIRS L3

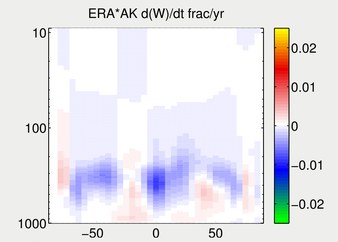


UMBC-AIRS (from radiance rates) and AIRS L3 (from rates of average AIRS L3 products) both see significant stratospheric cooling in Southern Hemisphere include 0.002 K/yr instr drift → UMBC retrieved dT/dt uncertainty ≤ 0.018 K/yr

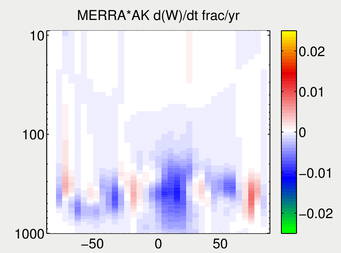
WV(z) rate from UMBC-AIRS



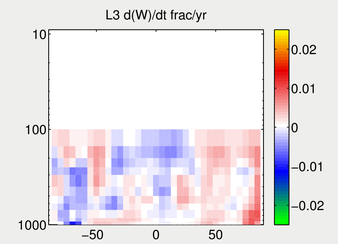
WV(z) rate from ERA * avg kernel



WV(z) rate from MERRA * avg kernel



WV(z) rate from AIRS L3



AIRS L3 water vapor product cuts off at 100 mb. UMBC-AIRS rates are more similar to re-analysis (ERA and MERRA) than AIRS L3

UMBC retrieved dWV(frac)/dt uncertainty ≤ 0.005 /yr (includes instr drift)