

All-Sky AIRS Anomaly Retrievals using Zonally Gridded, Time Averaged Brightness Temperature Spectra

AIRS Science Team Meeting

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Overview

Overview of talk

- Larrabee's talk shows we have established high stability of AIRS(LW/MW)
 - we used noise covariance based on $\langle \text{NedT} \rangle$ per latitude bin
 - instead of using SARTA jacobians for anomalies, we used kCARTA with latest spectroscopy (LBLRTM 12.8 for CO₂,CH₄), HITRAN 2016 for other gases, CKD 3.2
 - plus we also know kCARTA jacobians work fine for any CO₂/T combinations
- Using lessons learned from clear sky spectral anomaly and rate retrievals we are now beginning to work with allsky spectral anomalies and trends.
- kCARTA can do very similar TwoSlab calcs to SARTA, so no problems using it for allsky T/WV/O₃,surftemp jacobians; for this talk we use SARTA for cloud jacobians
- In this talk we show zonally averaged anomalies
- Long term goal is gridded anomalies, and trends derived from those anomalies

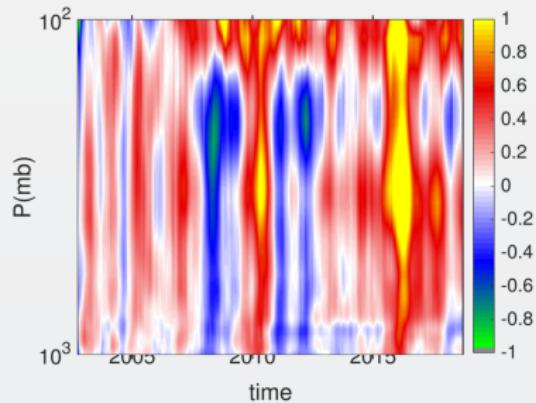
Clear Sky vs ERA Anomalies

Clear Sky Retrievals

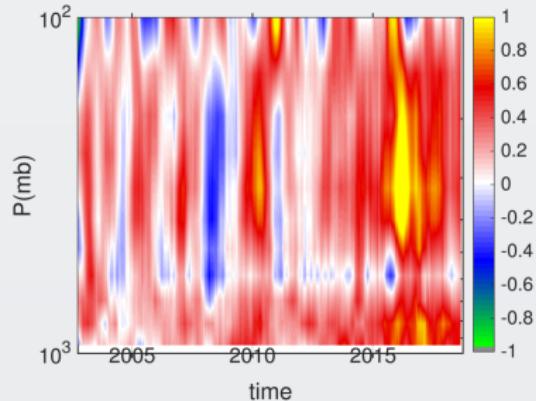
- Larrabee's talk gives details (data from 2002/09 to 2018/08)
 - 16 years of data divided into 16 day averages → 365 timesteps
 - **AIRS observations sampled for CLEAR scenes in these bins**
 - binned into 40 equal area latitude bins (thinner in equator/thicker at polar regions)
 - BT anomalies and average ERA profiles for all 365 timesteps
- kCARTA analytic jacobians for surface temperature, $T(z)$, $\text{WV}(z)$, $\text{O}_3(z)$
- Ran off kCARTA at $t=0$ to $t=T$ to make “finite difference” column trace gas jacobians (CO_2 , N_2O , CH_4 , CFC11 , CFC12)
- Using these jacobians, we retrieved $T(t,z)$, $\text{WV}(t,z)$, $\text{O}_3(t,z)$, $\text{CO}_2(t)$, $\text{N}_2\text{O}(t)$, $\text{CH}_4(t)$, $\text{CFC11}(t)$, $\text{CFC12}(t)$, $\text{surftemp}(t)$ at each of the 40 latbins \times 365 timesteps

Tropical Clear Sky Geophysical Anomalies : $T(z,t)$

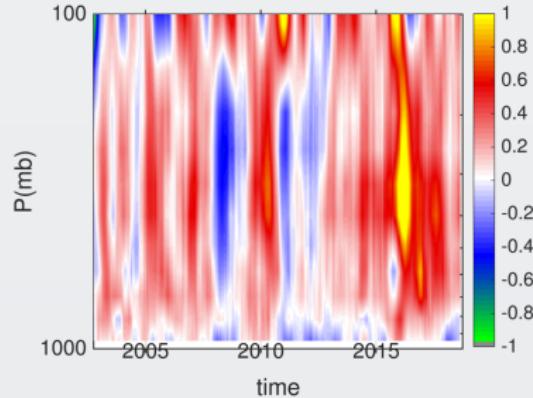
ERA



UMBC Retr Obs

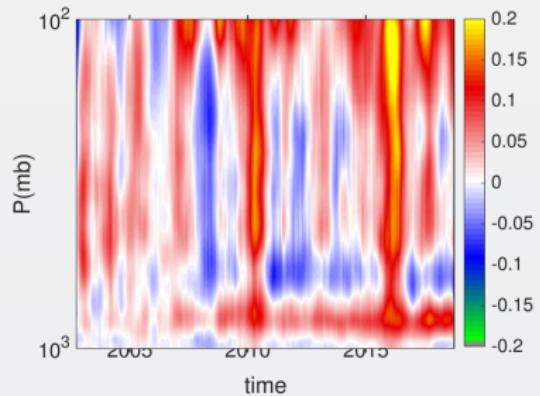


UMBC Retr Calc

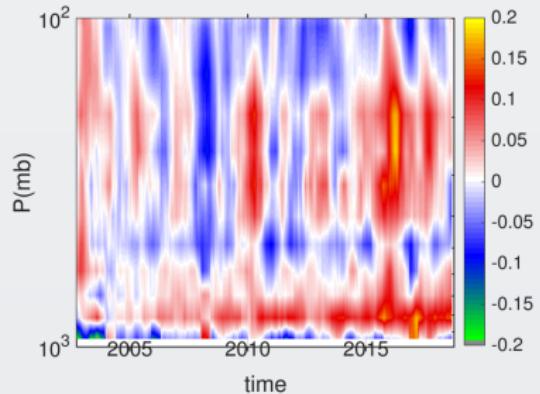


Tropical Clear Sky Geophysical Anomalies : $\text{frac WV}(z,t)$

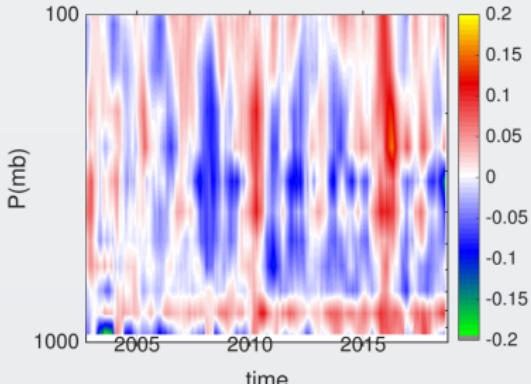
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UMBC Retr Obs

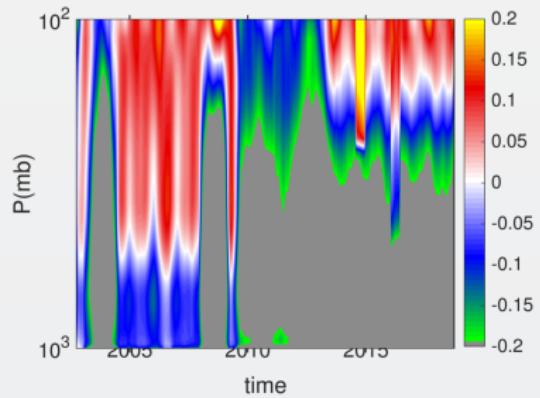


UMBC Retr Calc

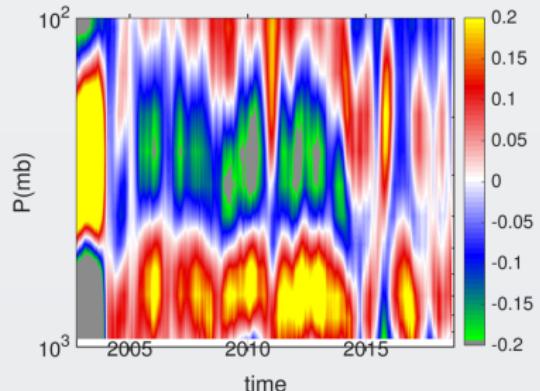


Tropical Clear Sky Geophysical Anomalies : $\text{frac O3}(z,t)$

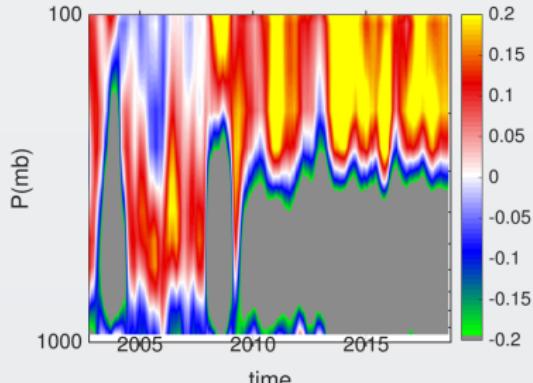
ERA



UMBC Retr Obs

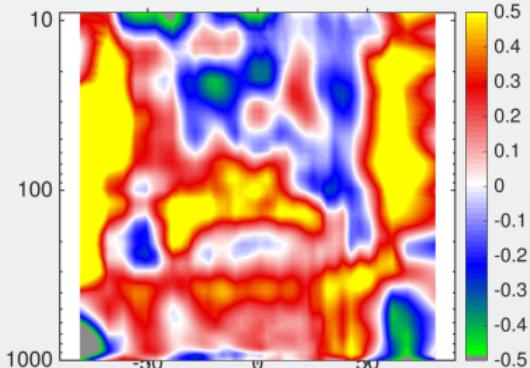


UMBC Retr Calc

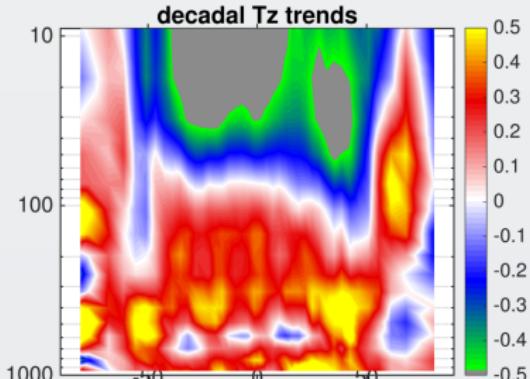


UMBC Retrieved Clear Sky OBS Geophysical Anomalies → Decadal Geophysical Rates : $T(z, \text{lat})$

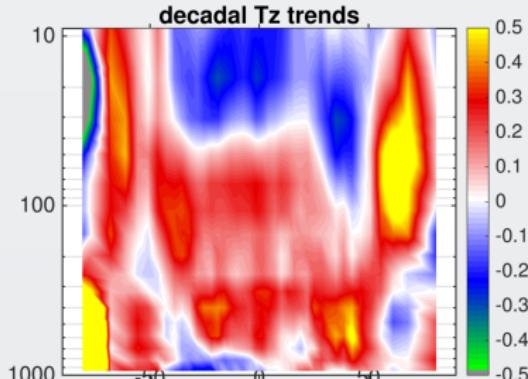
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UMBC Retr Obs

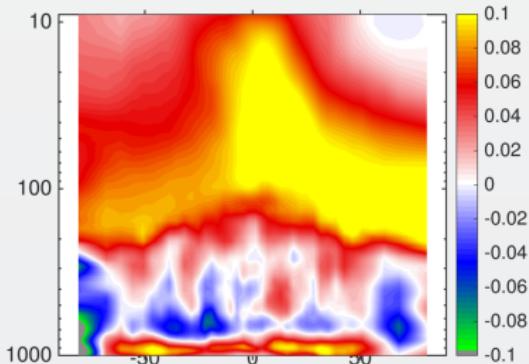


UMBC Retr Calc

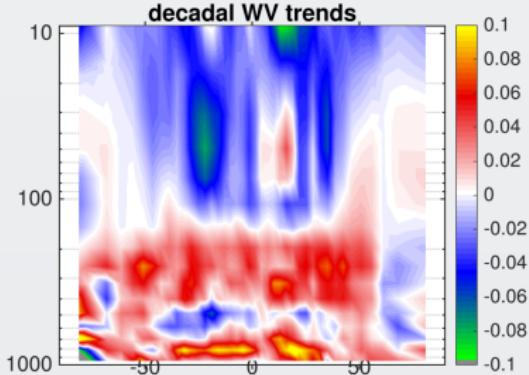


UMBC Retrieved Clear Sky OBS Geophysical Anomalies → Decadal Geophysical Rates : WV(z,lat)

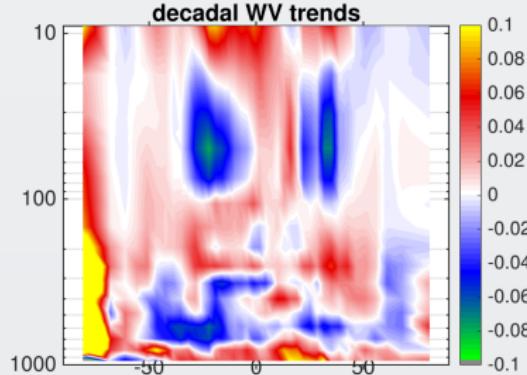
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UMBC Retr Obs

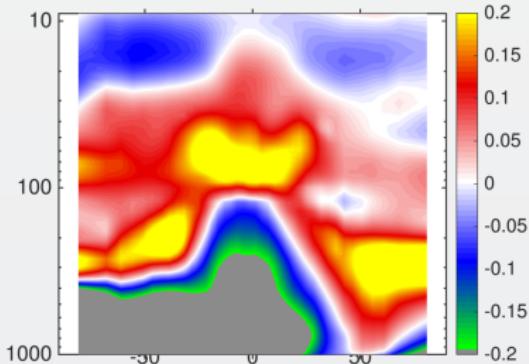


UMBC Retr Calc

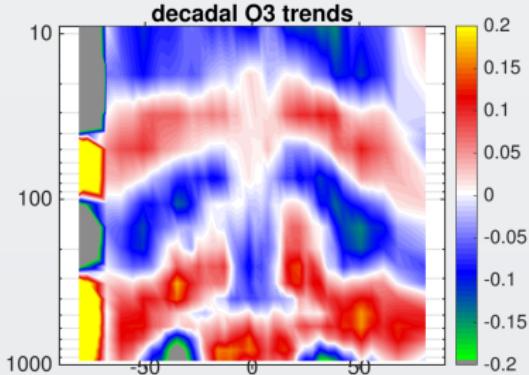


UMBC Retrieved Clear Sky OBS Geophysical Anomalies → Decadal Geophysical Rates : O3(z,lat)

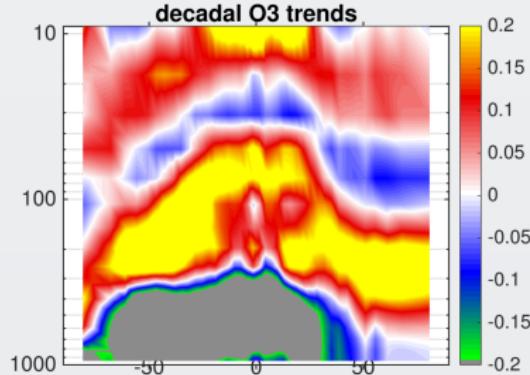
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UMBC Retr Obs



UMBC Retr Calc



AllSky Results

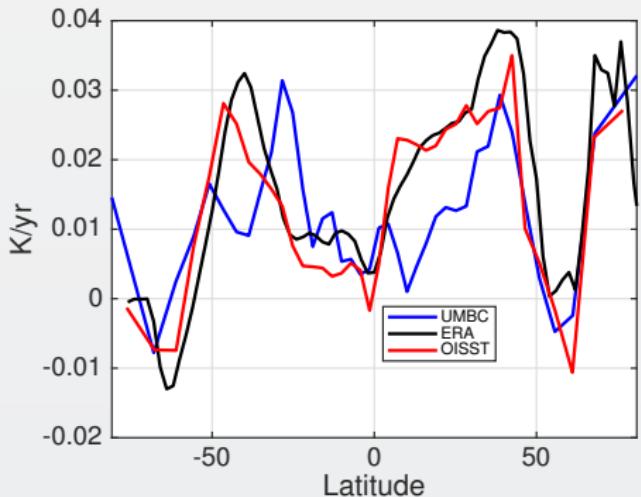
AllSky Retrievals

- Interested in a less specialized sampling, so will now look at allsky rates
- Larrabee's talk gives details (data from 2002/09 to 2018/08)
 - binned into 40 equal area latitude bins (thinner in equator/thicker at polar regions)
 - AIRS observations randomly sampled from these bins
 - 16 years of data divided into 16 day averages → 365 timesteps
 - BT anomalies and average ERA profiles for all 365 timesteps
- kCARTA analytic jacobians for surface temperature, $T(z)$, $\text{WV}(z)$, $\text{O}3(z)$ using TwoSlab Clouds
- kCARTA at $t=0$ to $t=T$ to make "finite difference" column trace gas jacobians (CO_2 , N_2O , CH_4 , CFC11 , CFC12)
- SARTA for cloud jacs
- Using these jacobians, we retrieved
 $T(t,z)$, $\text{WV}(t,z)$, $\text{O}3(t,z)$, $[\text{CO}_2(t), \text{N}_2\text{O}(t), \text{CH}_4(t), \text{CFC11}(t), \text{CFC12}(t), \text{surften}]$
[cld amount/cld eff size/ cld top for liquid/ice clouds] at each of the 40 latbins × 365 timesteps

AllSky OCEAN

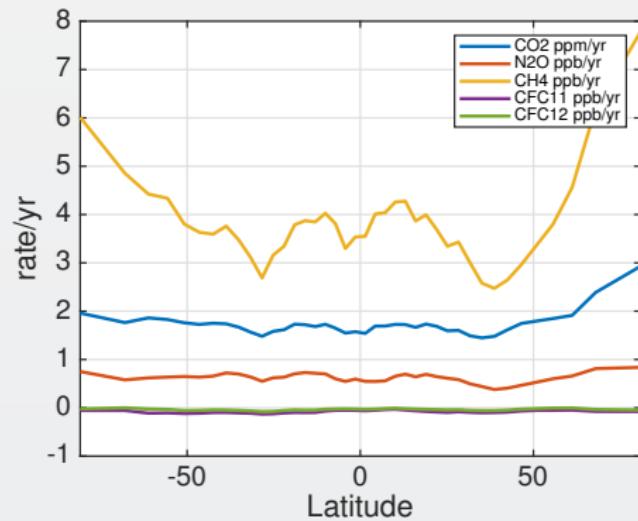
Geophysical rates from spectral rates (contd)

Stemp Rates



This is over ocean only

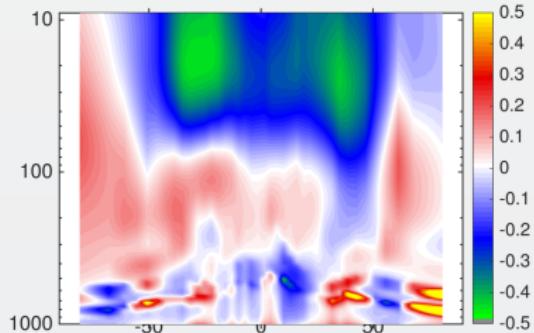
Trace gas rates



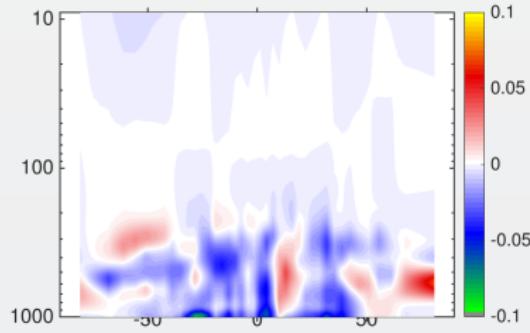
Preliminary work

UMBC AllSky OCEAN Spectral Rates → AllSky Geophysical Rates

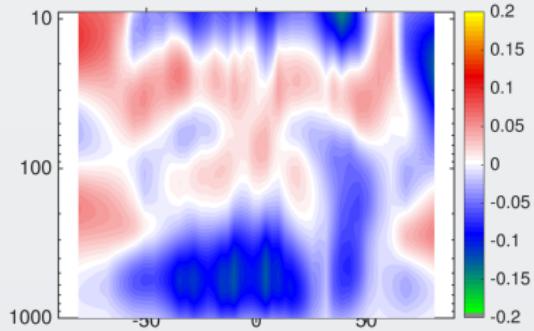
$dT(z,t)/dt$



$\frac{d}{dt} dWV(z,t)$

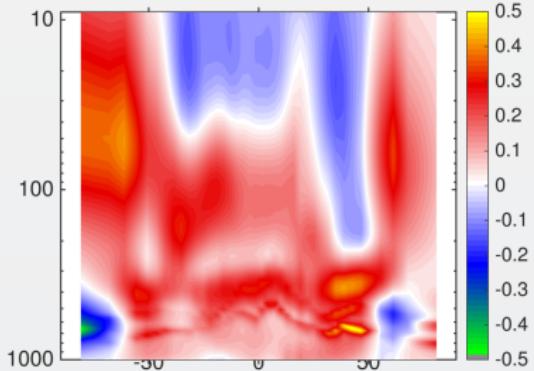


$\frac{d}{dt} dO3(z,t)$

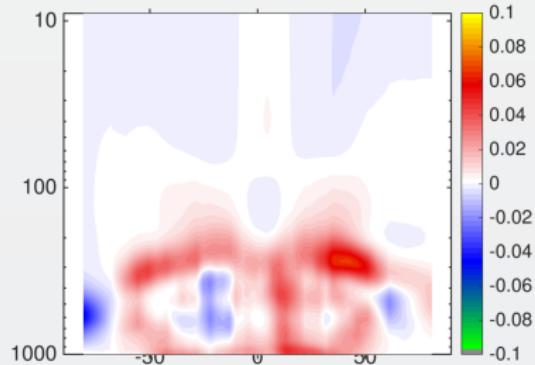


ERA AllSky OCEAN Rates → AllSky AK × Rates

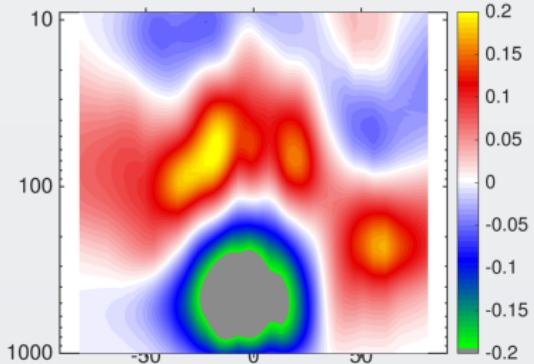
$dT(z,t)/dt$



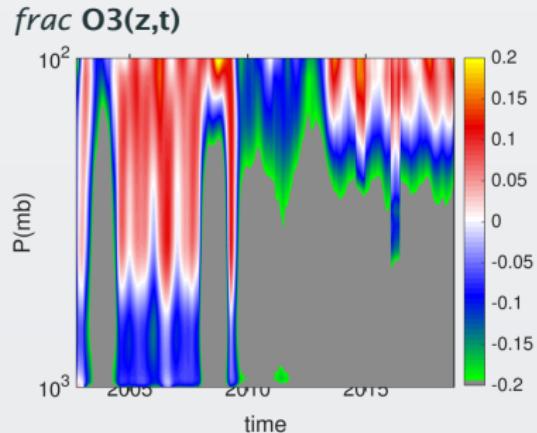
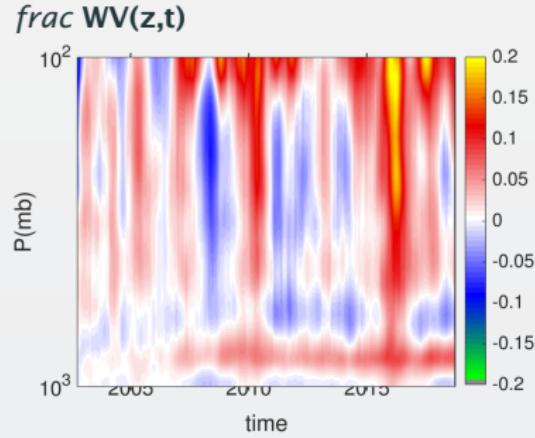
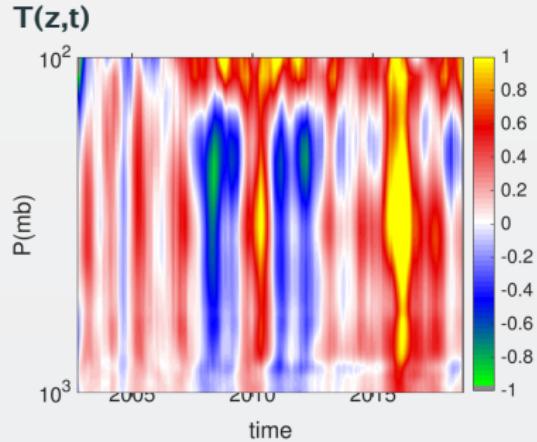
$\frac{d}{dt} \text{dWV}(z,t)$



$\frac{d}{dt} \text{dO}_3(z,t)$



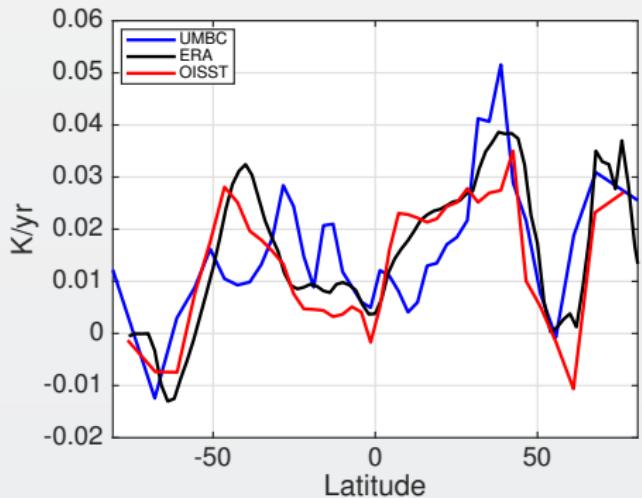
Tropical ERA AllSky Geophysical Anomalies



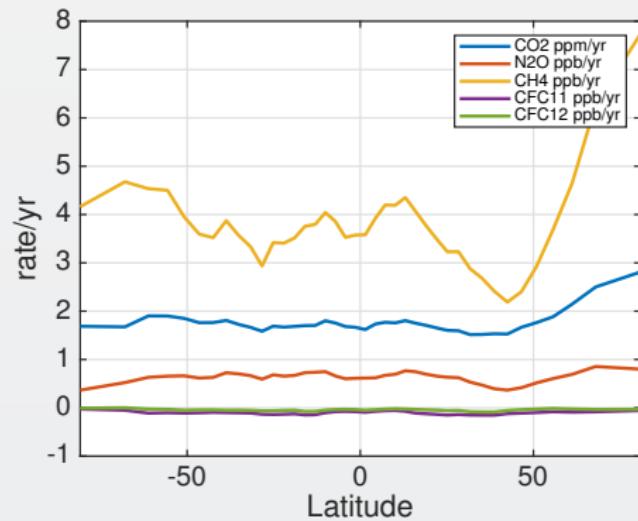
AllSky LAND/OCEAN

Geophysical rates from spectral rates (contd)

Stemp Rates



Trace gas rates

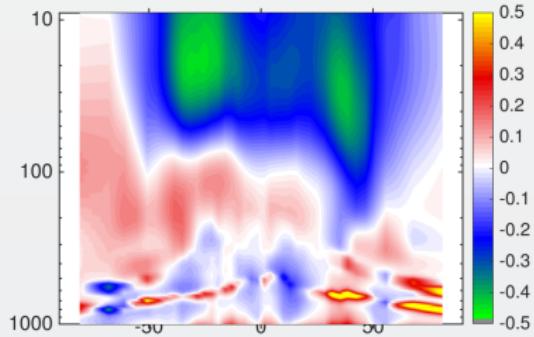


This is over ocean only

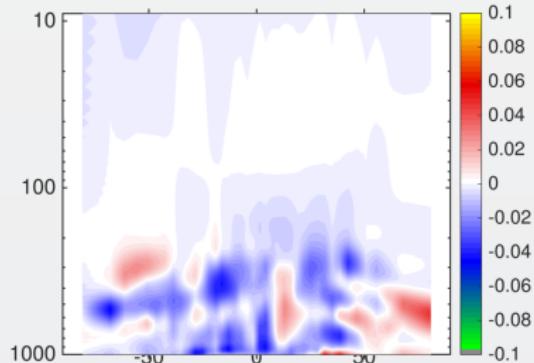
Preliminary work

UMBC AllSky OCEAN Spectral Rates → AllSky Geophysical Rates

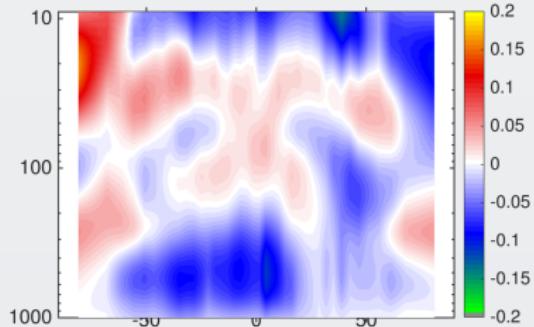
$dT(z,t)/dt$



$\frac{d}{dt} dWV(z,t)$

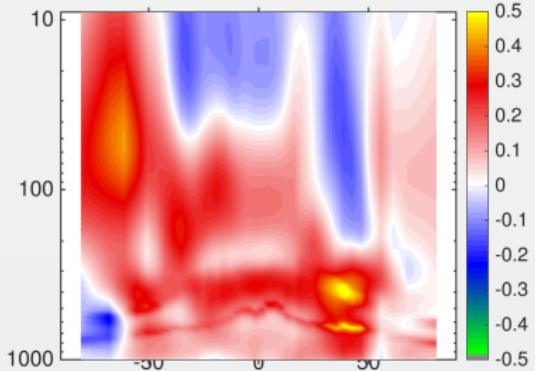


$\frac{d}{dt} dO3(z,t)$

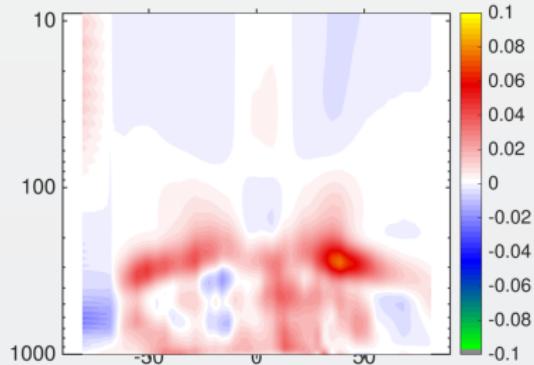


ERA AllSky OCEAN Rates → AllSky AK × Rates

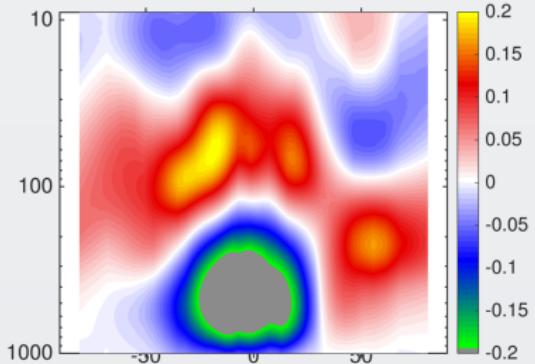
$dT(z,t)/dt$



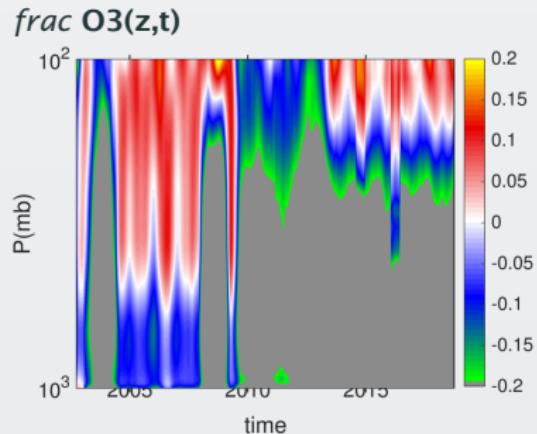
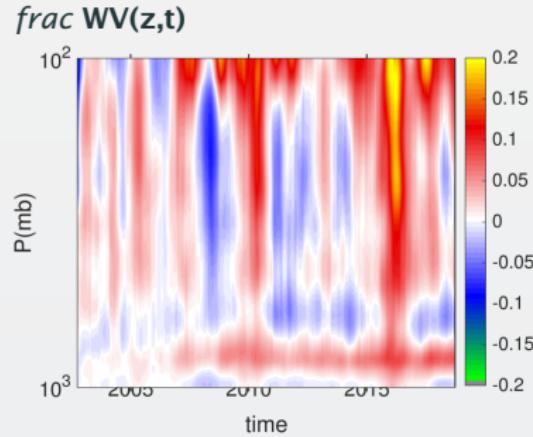
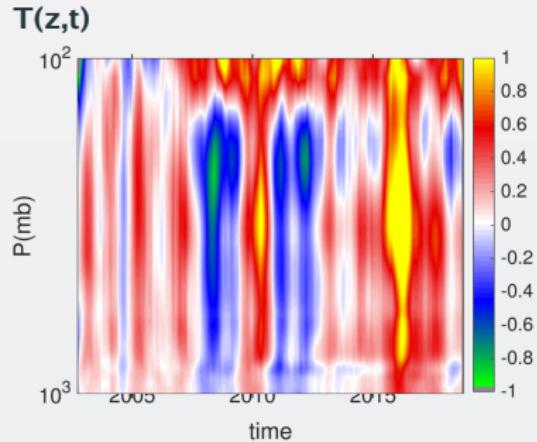
$\frac{d}{dt} dWV(z,t)$



$\frac{d}{dt} dO3(z,t)$



Tropical ERA AllSky Geophysical Anomalies



Conclusions

Conclusions

- Using lessons learned from clear sky spectral anomaly and rate retrievals (see Larrabee's talk), we are now beginning to work with allsky spectral anomalies and trends.
- Started to work with zonally averaged allsky spectra, rather problematic because of
 - too much cloud variability across latitude bins, especially with large 2016 ENSO
 - on surface rather hard to separate low cloud from surface temperature
- But using allsky spectral rates, we actually get
 - decent trace gas rates; but not from anomalies (so we tie the trace gases to known "trends")
 - using either spectral rates or anomalies, we are obtaining ballpark T/WV/O3 trends
 - we see recognizable features in anomalies eg QBO in tropical latbins
- Reminder : Long term goal is gridded anomalies, and trends derived from those anomalies