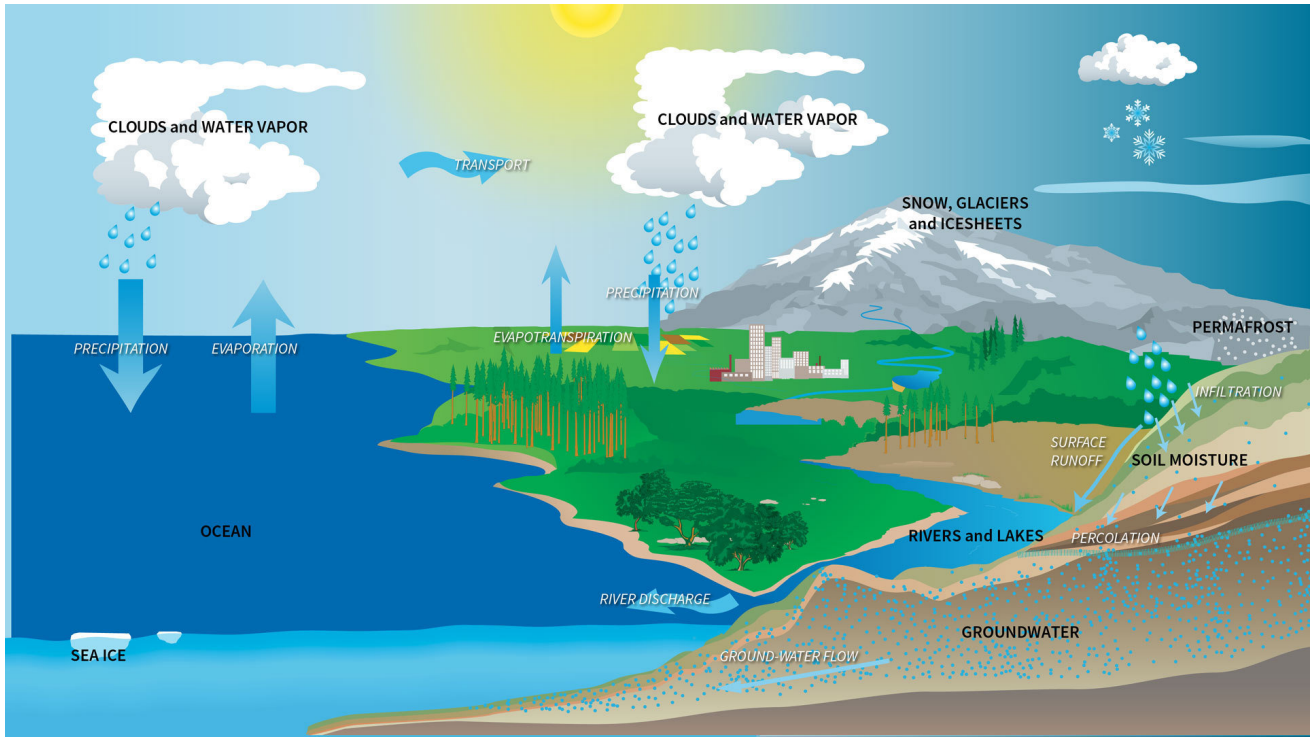
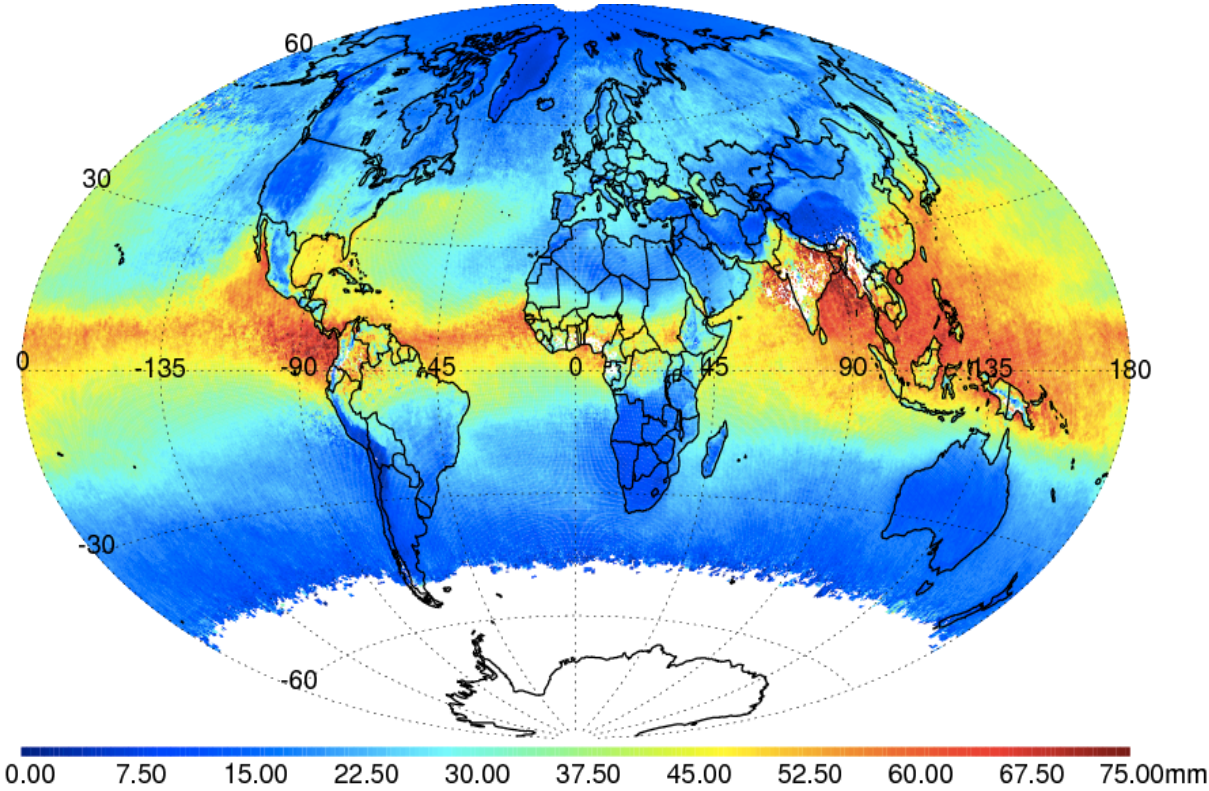
OMI Total Column Water Vapor (TCWV) from the Smithsonian Astrophysical Observatory



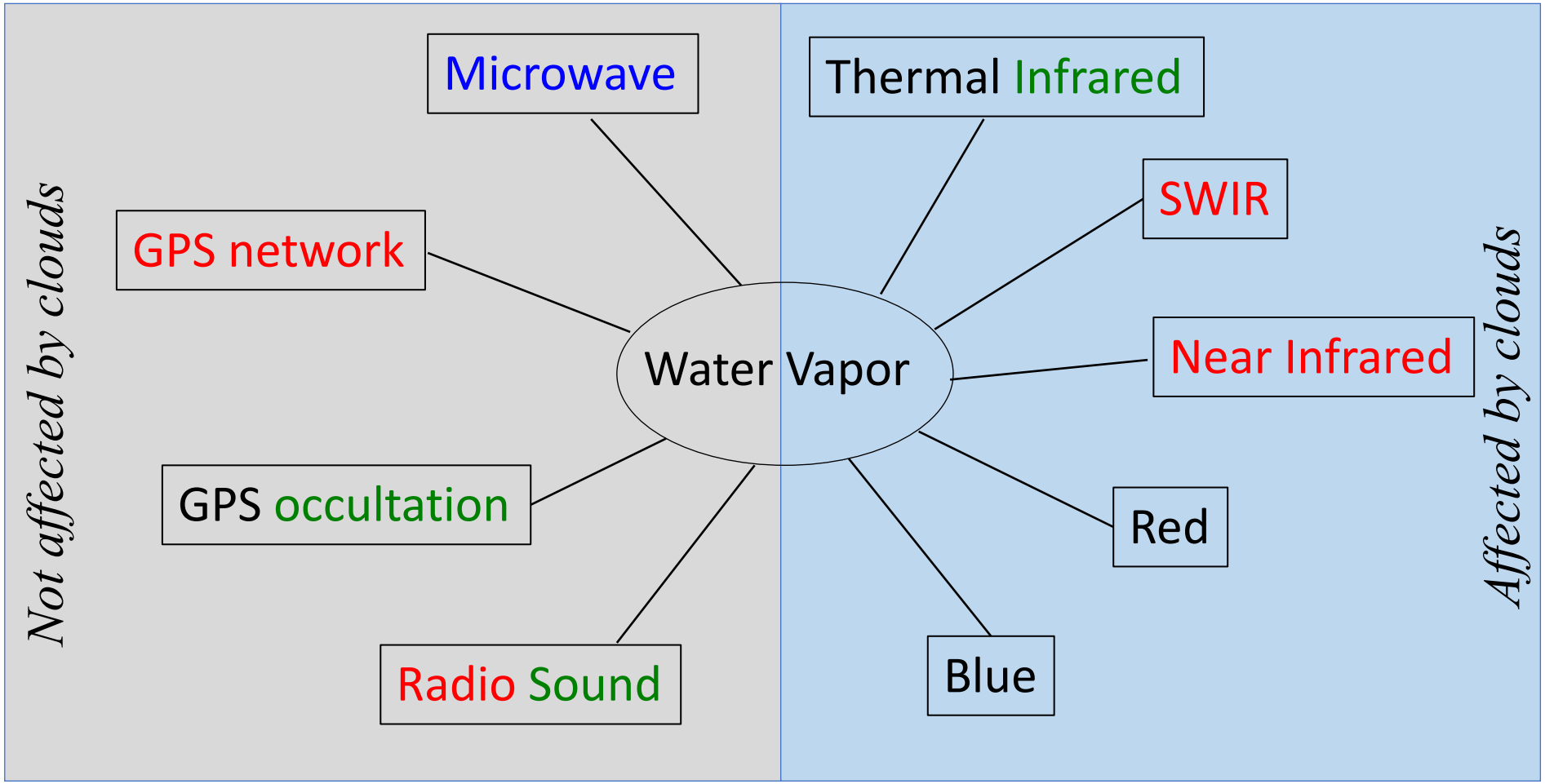


CENTER FOR ASTROPHYSICS
HARVARD & SMITHSONIAN

Huiqun (Helen) Wang (hwang@cfa.harvard.edu),

Amir H. Souri, Gonzalo Gonzalez Abad, Xiong Liu, Kelly Chance

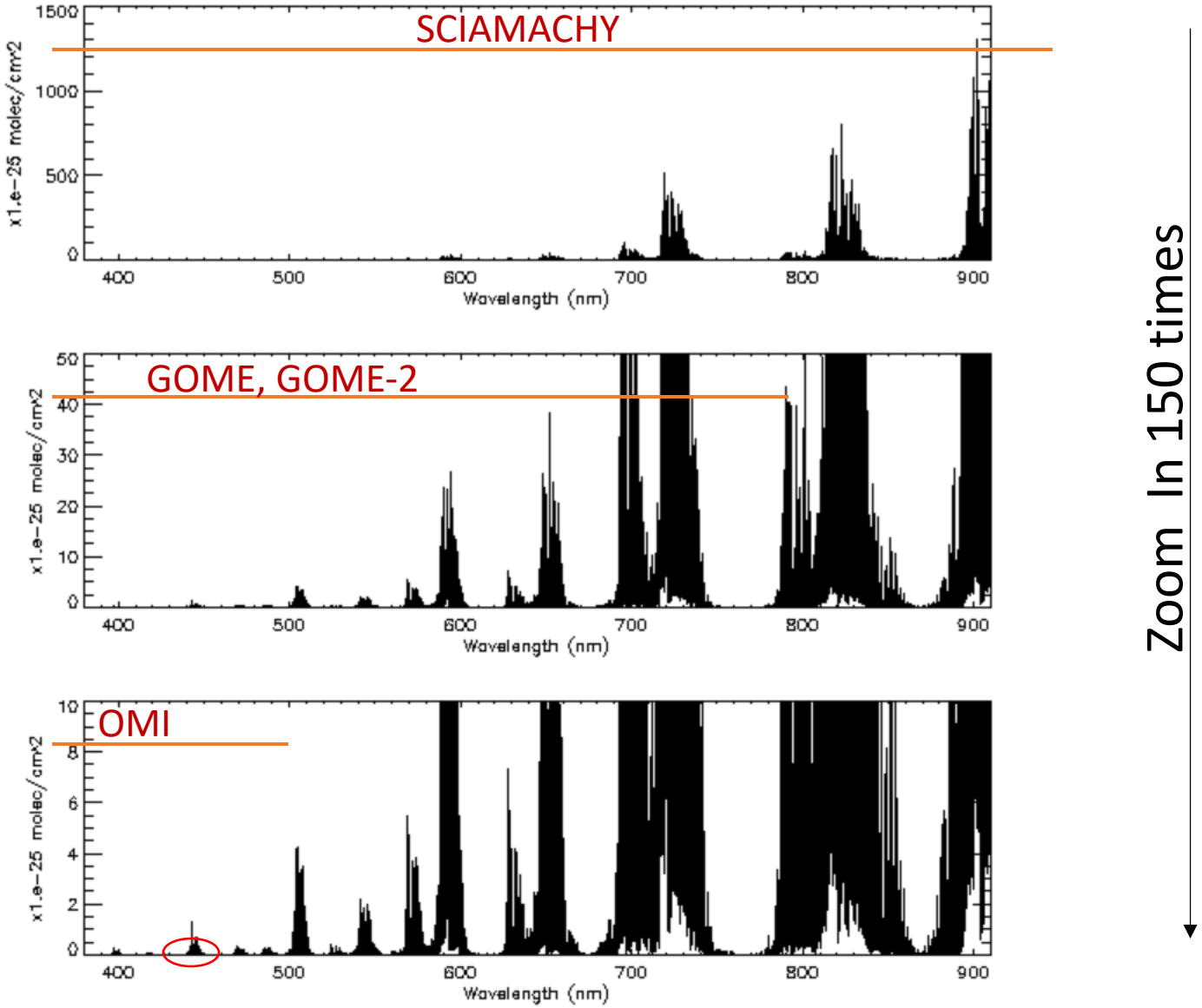
Measurement Technique



Total Column Water Vapor (TCWV): Land, Ocean, Both

Profiles

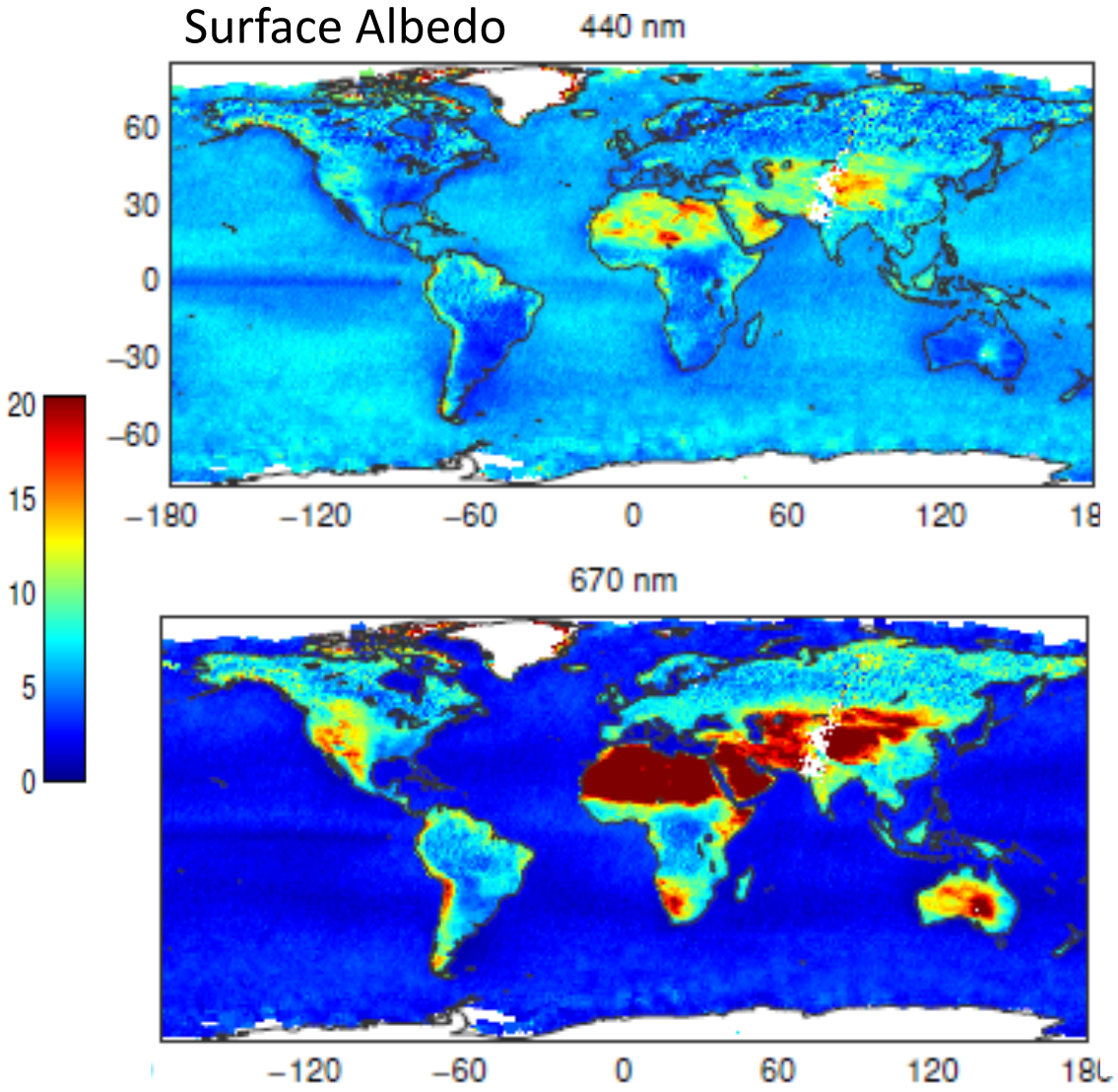
Water Vapor Spectrum

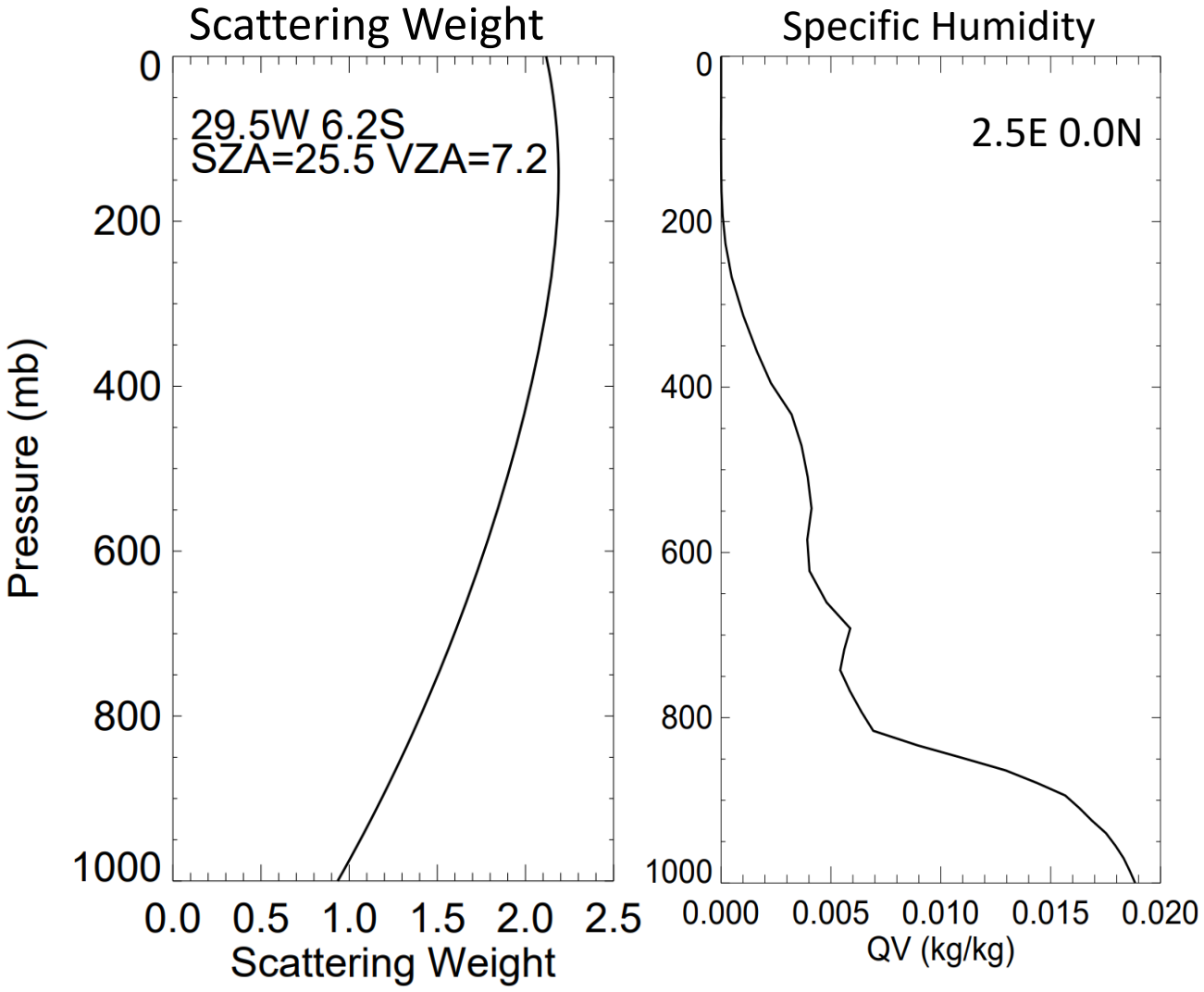


Much weaker absorption in blue, but still feasible [Wagner et al., 2013]

smaller SNR, but no saturation

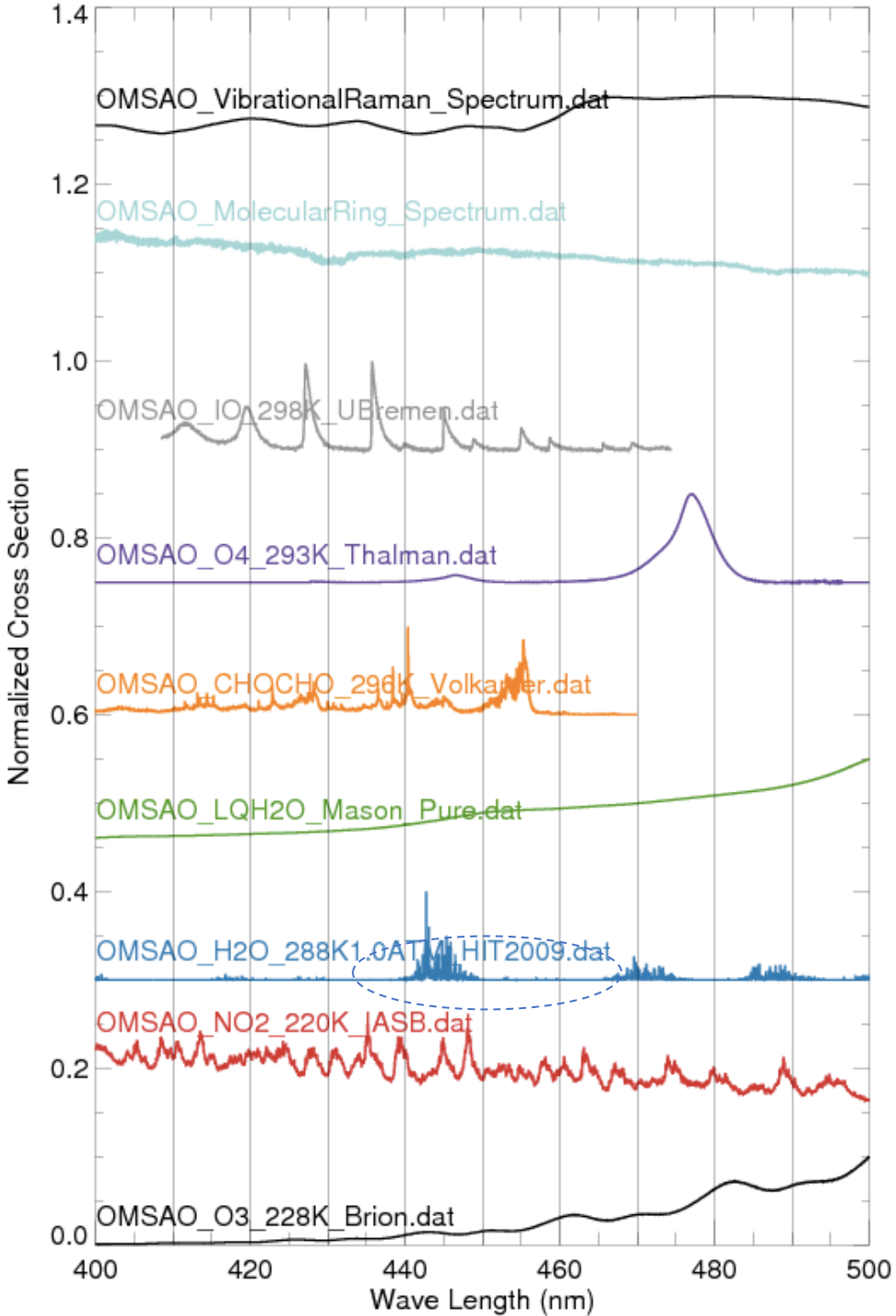
Advantages of OMI TCWV retrieval





More uniform surface albedo between land and ocean

Sensitive down to PBL where most water vapor resides



Retrieval Algorithm

(1) Slant Column Density (SCD) fitting: [432.0, 466.5]nm

3rd order closure polynomials

Wavelength shift, Under-sampling

H_2O, O_3, NO_2, O_4, liquid H_2O, IO, $C_2H_2O_2$

Ring, Water Ring, Air Vibrational Raman Scattering

(2) Vertical Column Density (VCD) = SCD/AMF

$$\text{AMF} = \int ScatteringWeight \bullet GasProfile \Big/ \int GasProfile$$

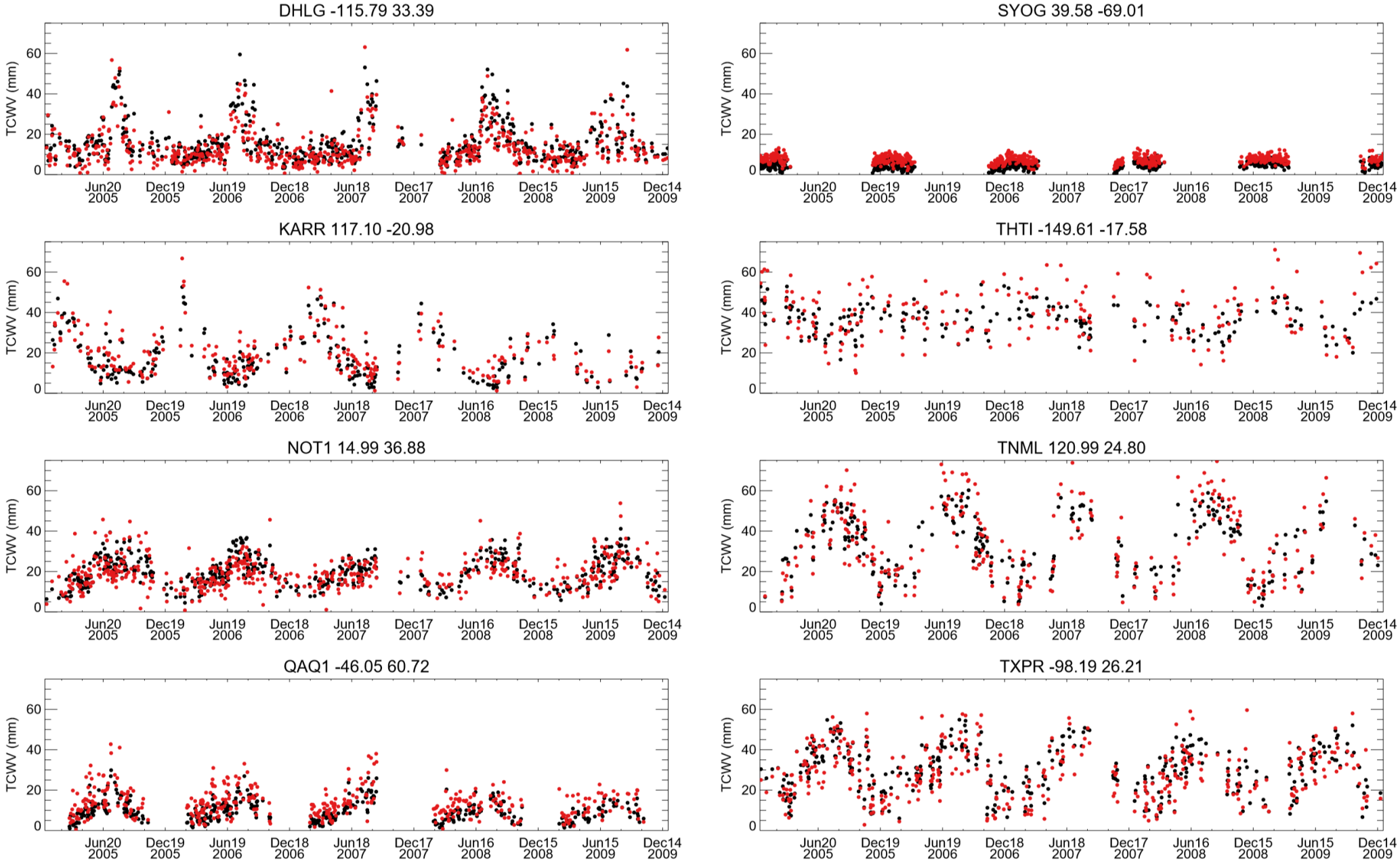
Geometry

Cloud fraction, cloud top pressure [Veefkind et al., 2016]

Surface albedo [Kleipool et al., 2008]

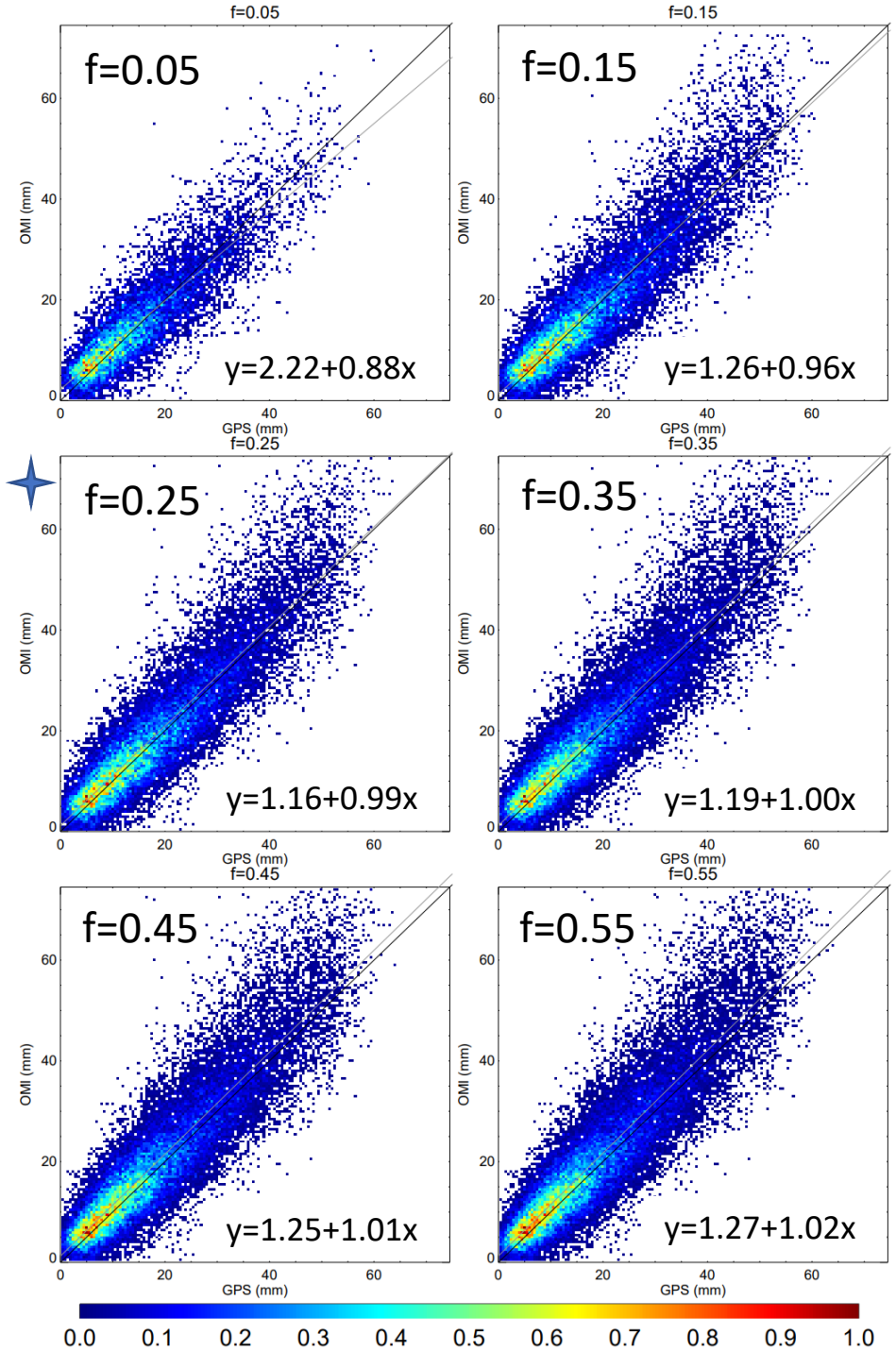
Surface pressure, gas profile (monthly MERRA-2)

TCWV Time Series – OMI and GPS

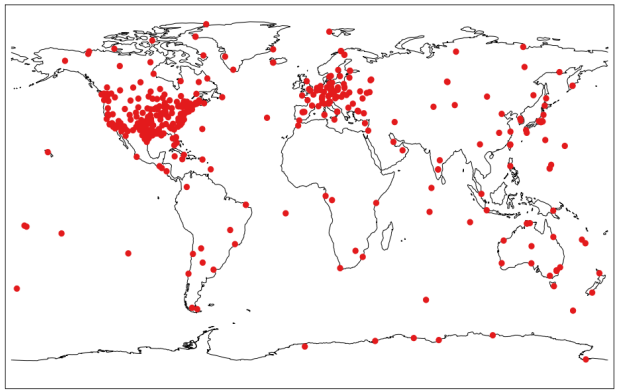


OMI data reproduce seasonal cycle of TCWV for a variety of climate regimes

OMI versus GPS network for 2006



GPS stations



NCAR (rda.ucar.edu/datasets/ds721.1)

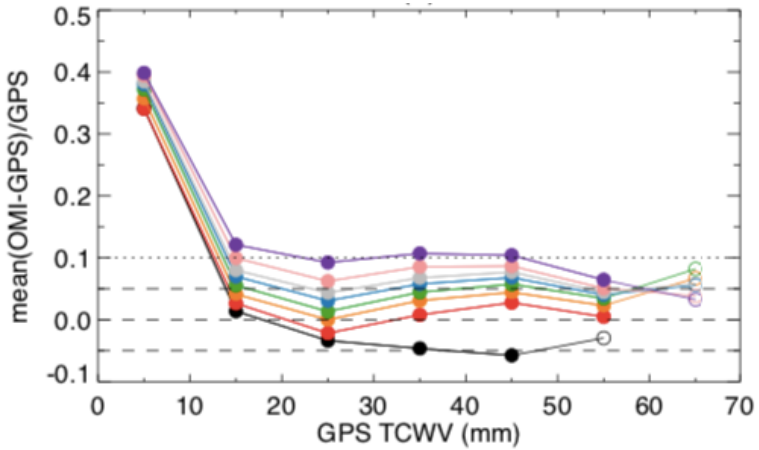
OMI Filtering Criteria:

- MainDataQualityFlag=0
- No row anomaly
- Fitting RMS<0.001
- 0<TCWV<75mm
- Cloud top pressure>750mb
- Cloud fraction <= threshold **f**

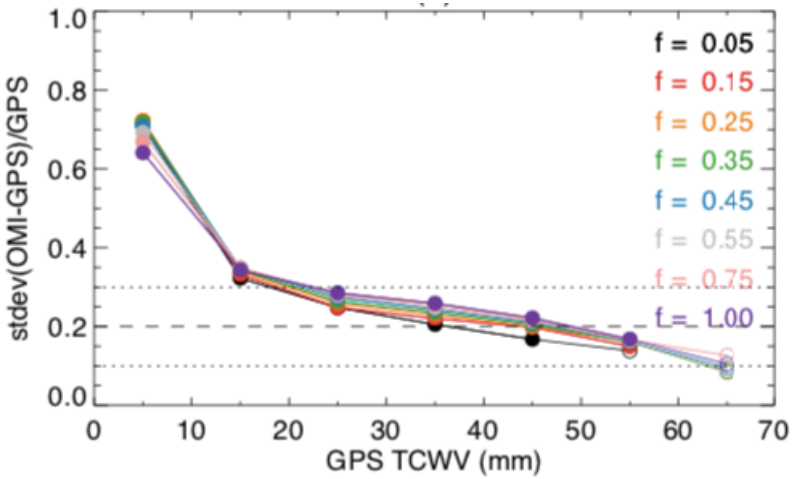
Co-location Criteria:

- Within 0.25° lat/lon
- Within 1.5 hours

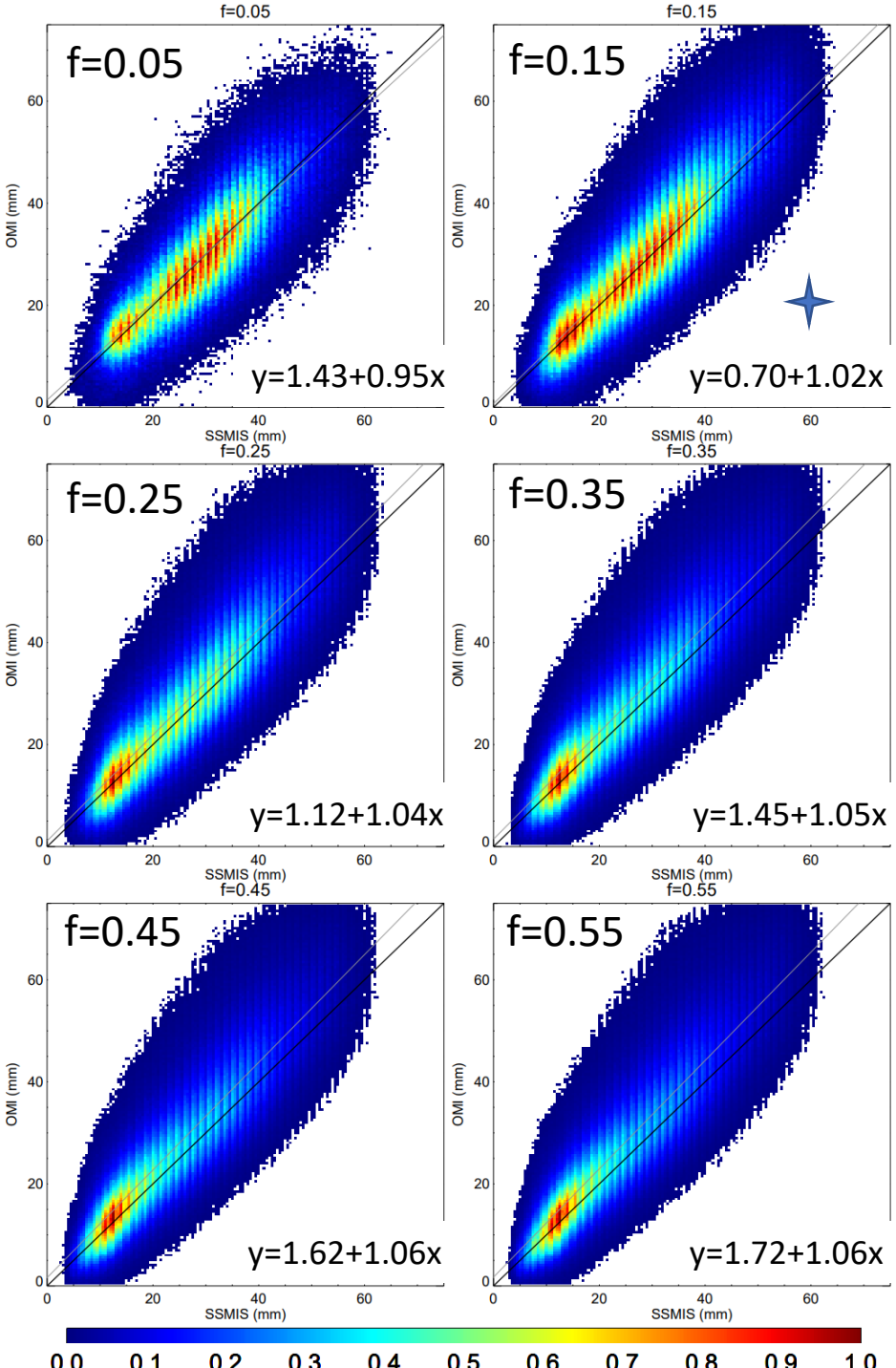
Relative Bias



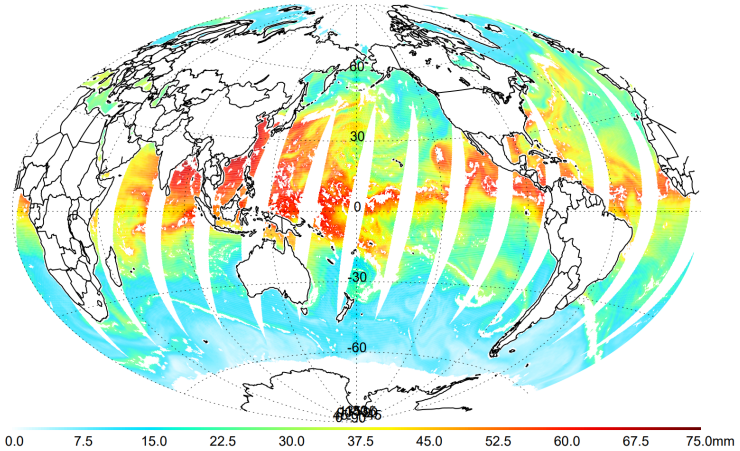
Relative Scatter



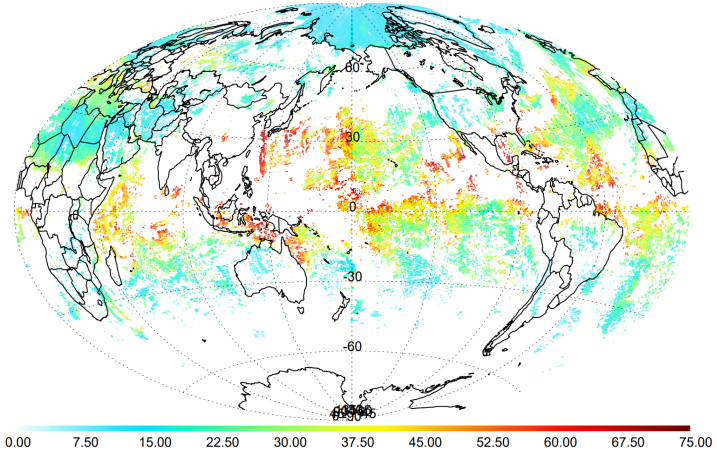
OMI versus SSMIS for July 2006



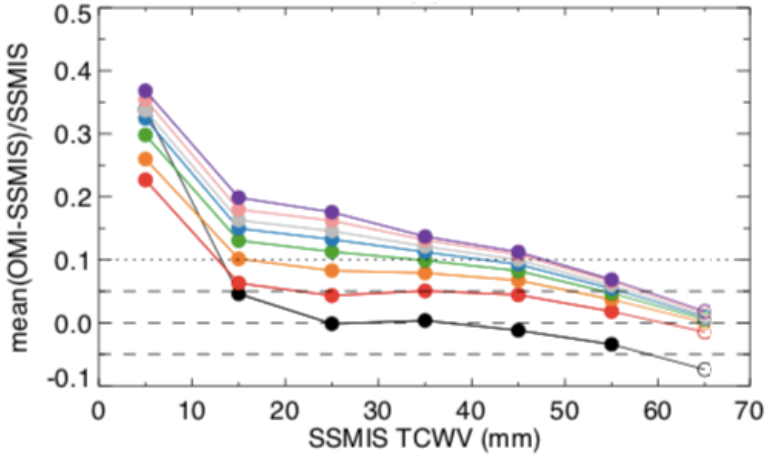
Remote Sensing System v7
SSMIS daily 0.25°x0.25°



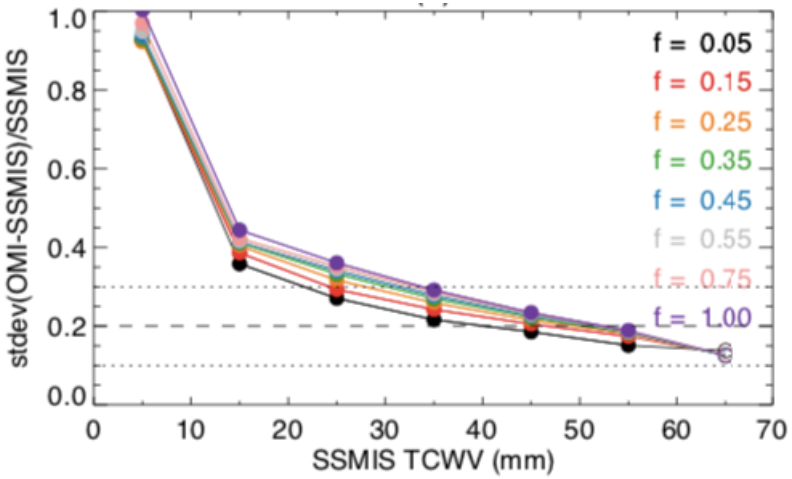
SAO v4
OMI daily 0.25°x0.25°



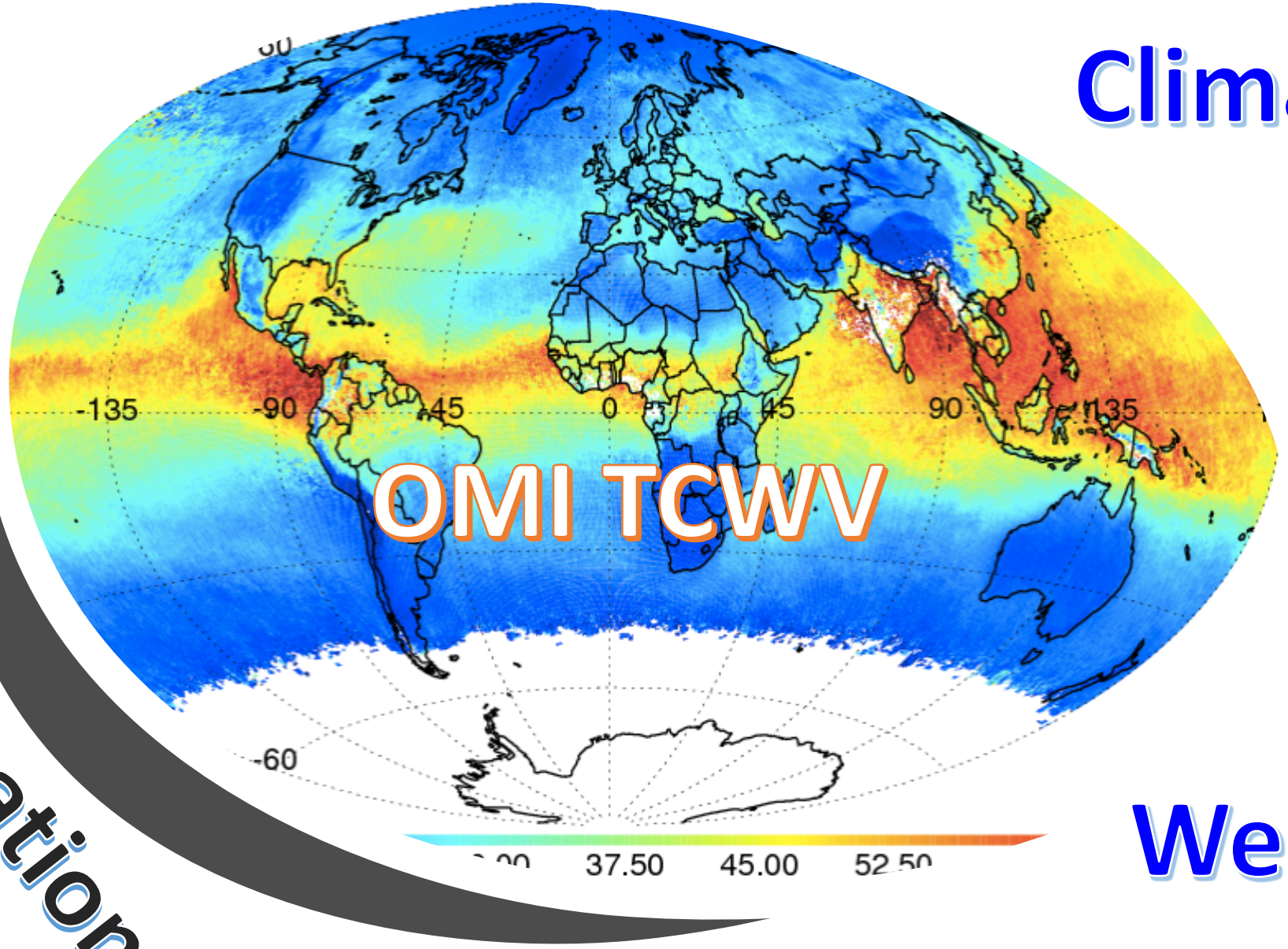
Relative Bias



Relative Scatter



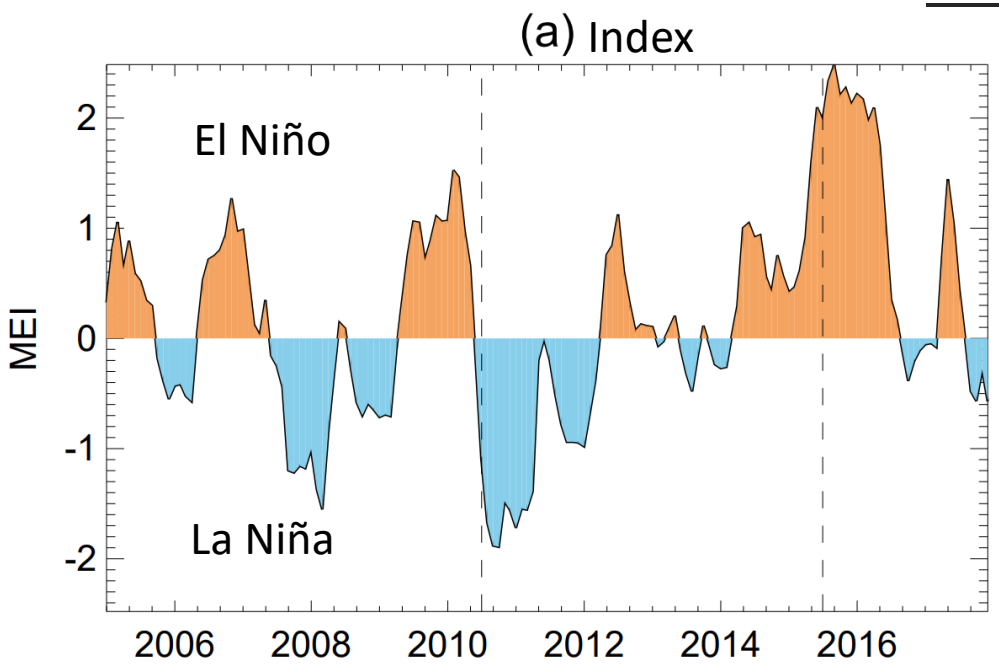
Applications

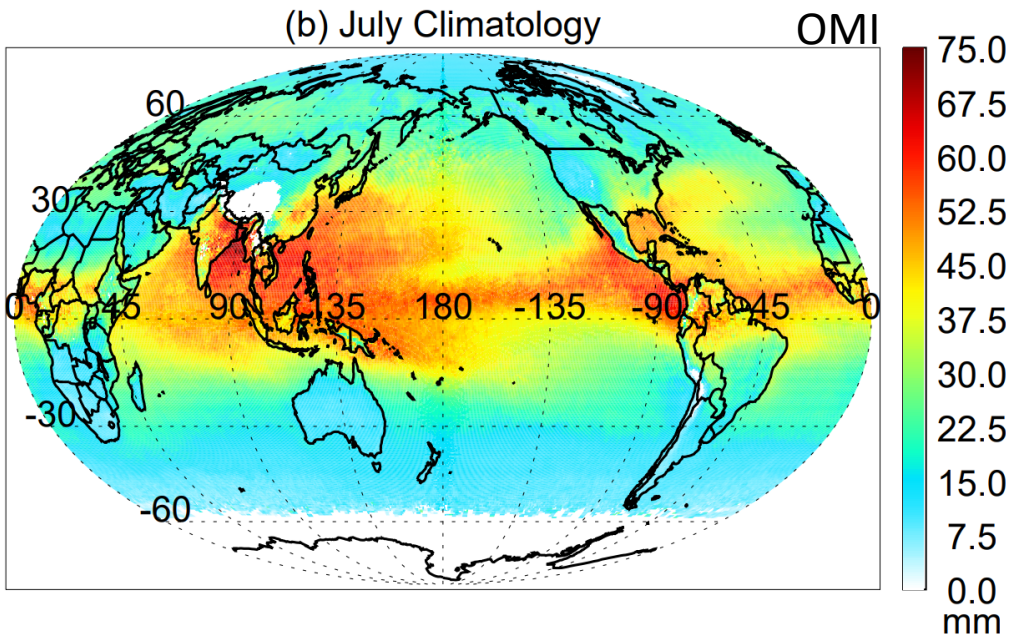


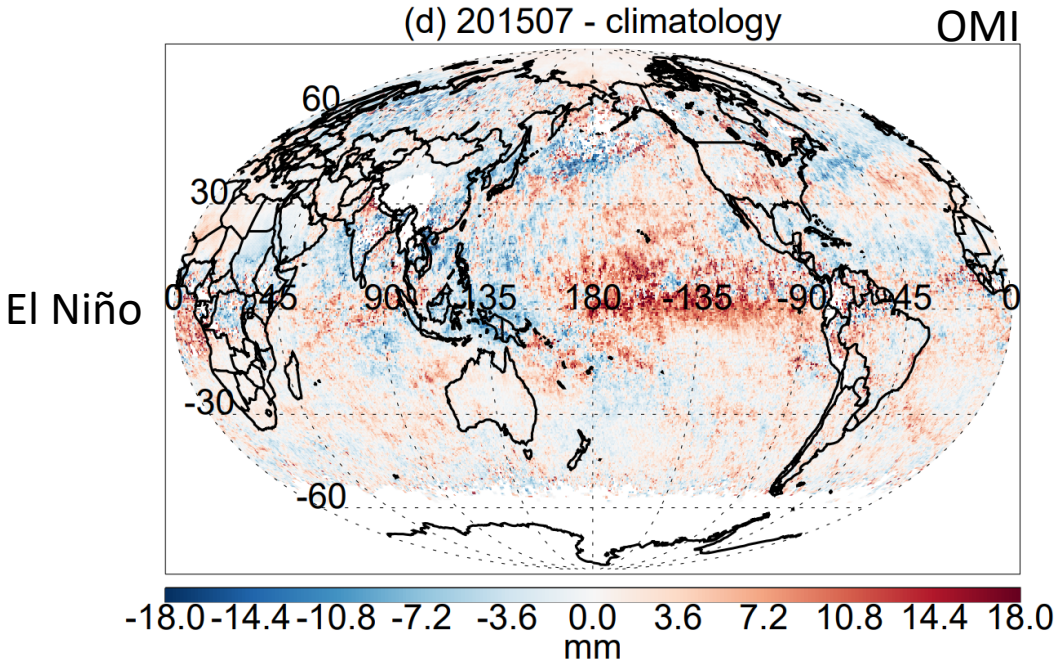
Climate

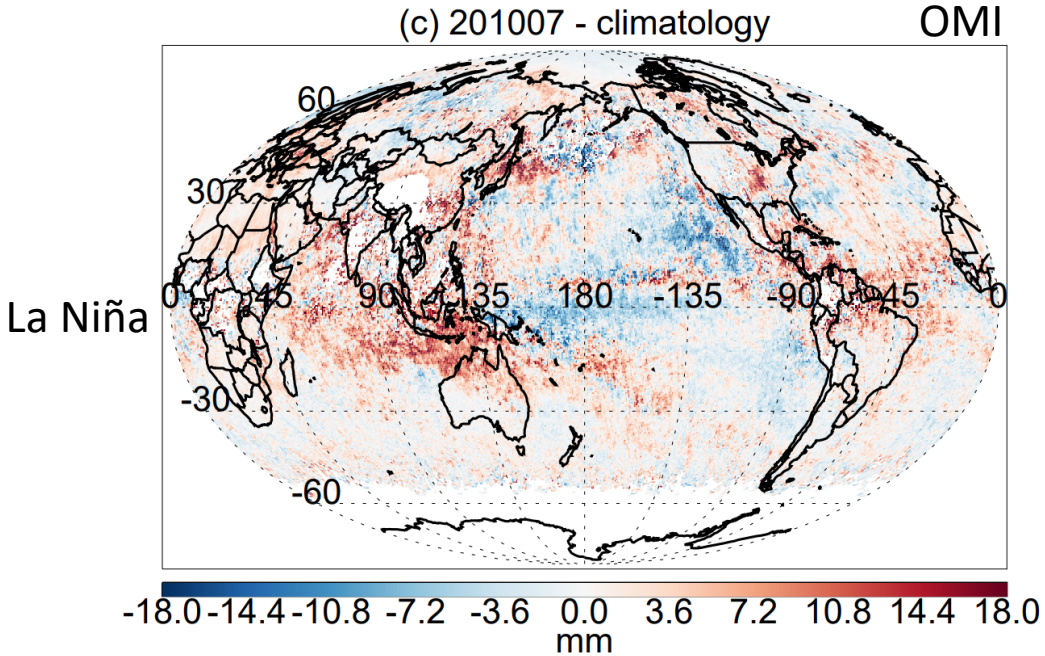
Weather

El Niño / La Niña

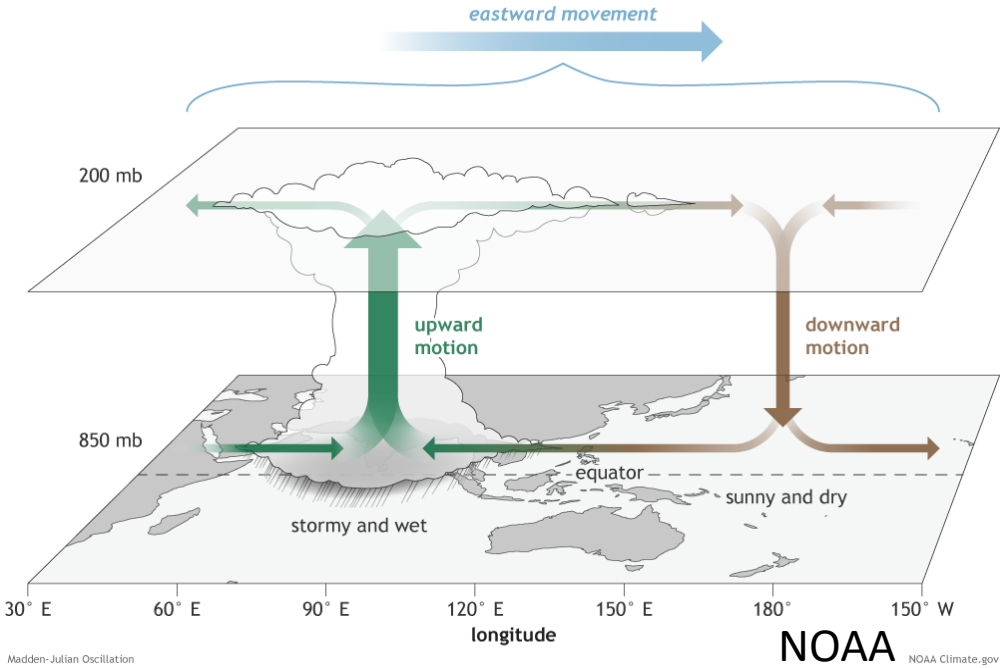






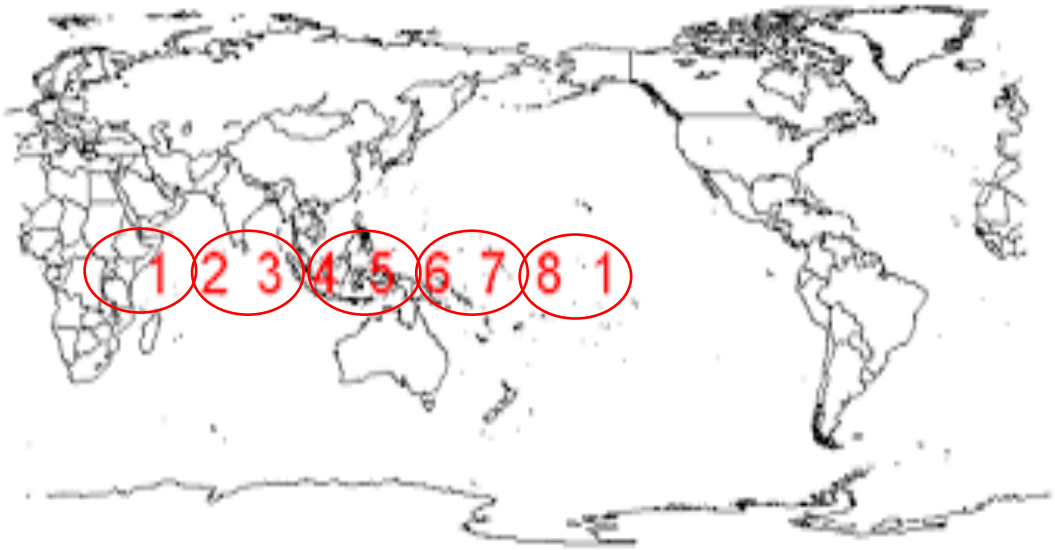


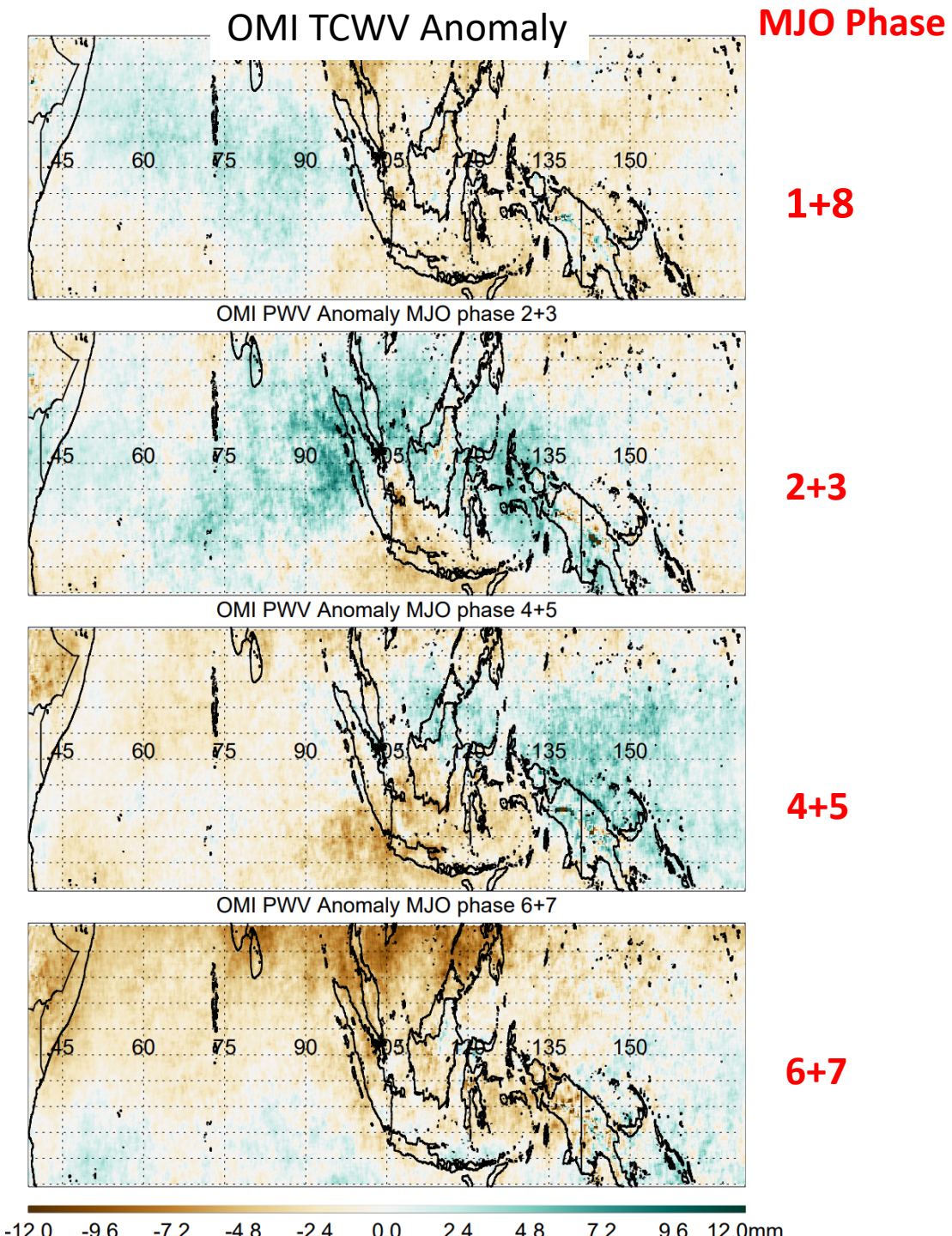
Madden-Julian Oscillation (MJO)



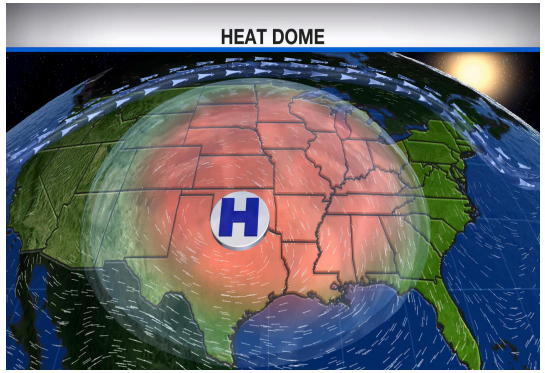
NOAA

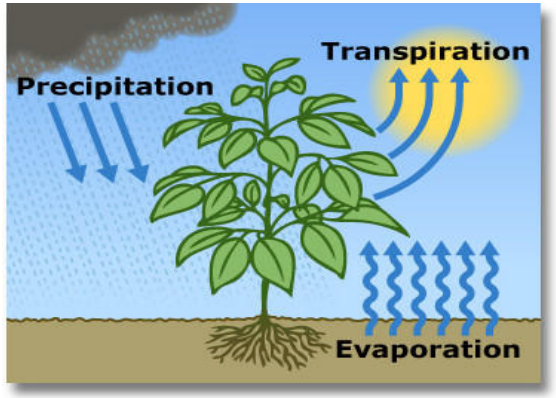
MJO Phases





Corn Sweat - Evapotranspiration





NWS Heat Index — Temperature (°F)

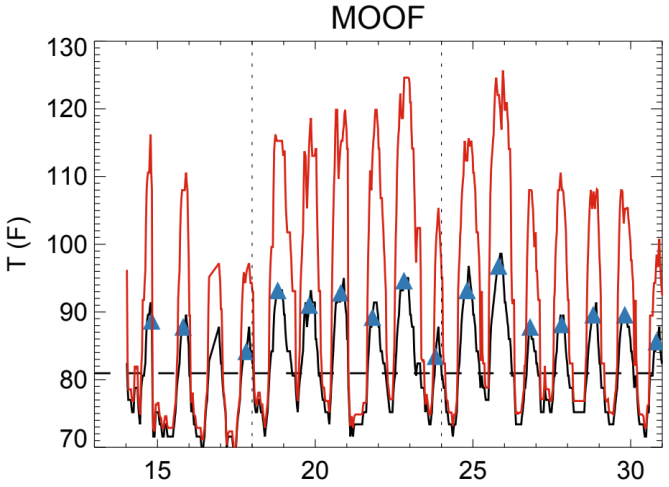
Relative Humidity (%)	80	82	84	86	88	90	92	94	96	98	100	102	104	106	108	110
40	80	81	83	85	88	91	94	97	101	105	109	114	119	124	130	136
45	80	82	84	87	89	93	96	100	104	109	114	119	124	130	137	
50	81	83	85	88	91	95	99	103	108	113	118	124	131	137		
55	81	84	86	89	93	97	101	106	112	117	124	130	137			
60	82	84	88	91	95	100	105	110	116	123	129	137				
65	82	85	89	93	98	103	108	114	121	128	136					
70	83	86	90	95	100	105	112	119	126	134						
75	84	88	92	97	103	109	116	124	132							
80	84	89	94	100	106	113	121	129								
85	85	90	96	102	110	117	126	135								
90	86	91	98	105	113	122	131									
95	86	93	100	108	117	127										
100	87	95	103	112	121	132										

Likelihood of Heat Disorders with Prolonged Exposure or Strenuous Activity

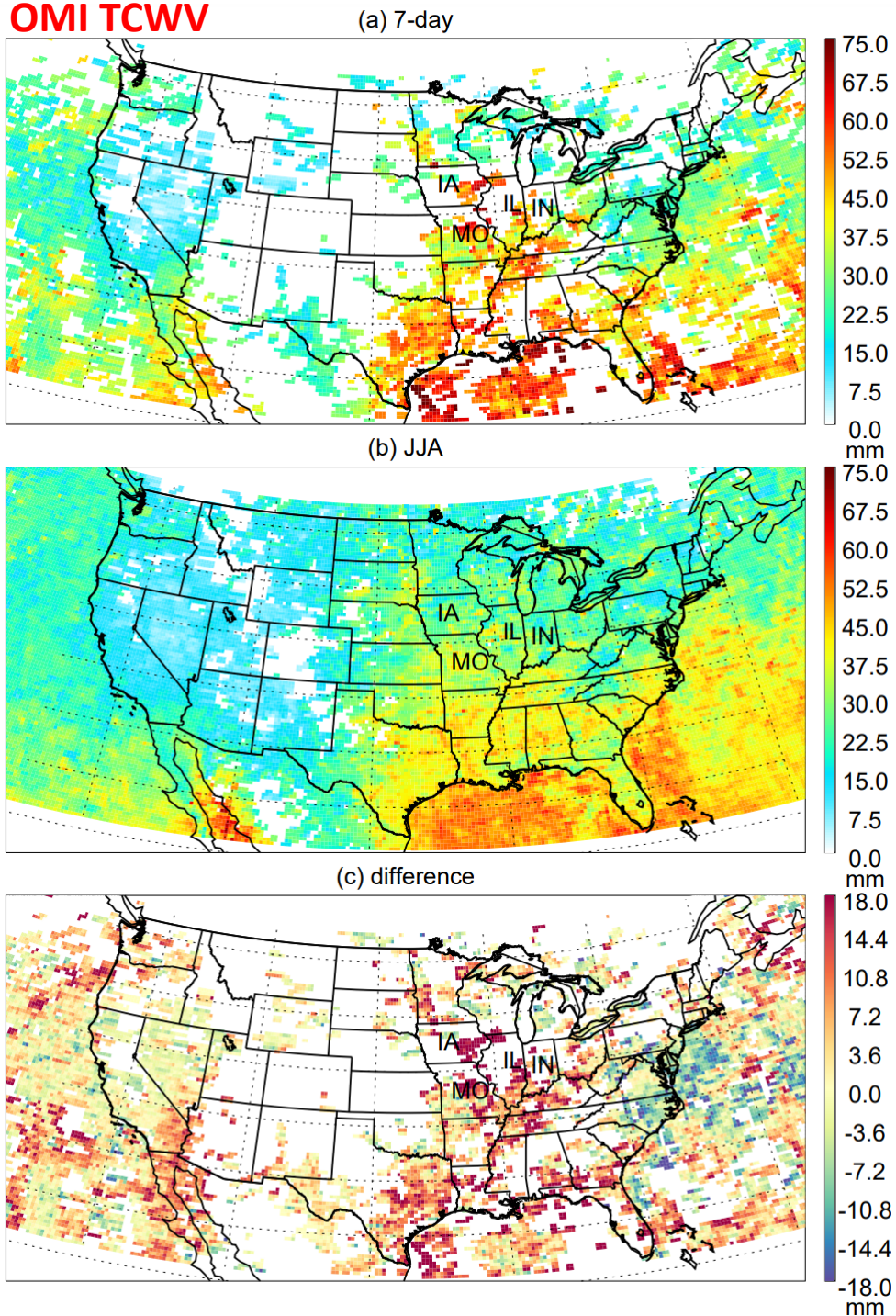
Caution | Extreme Caution | Danger | Extreme Danger

July 18-24, 2016

Temperature & Heat Index



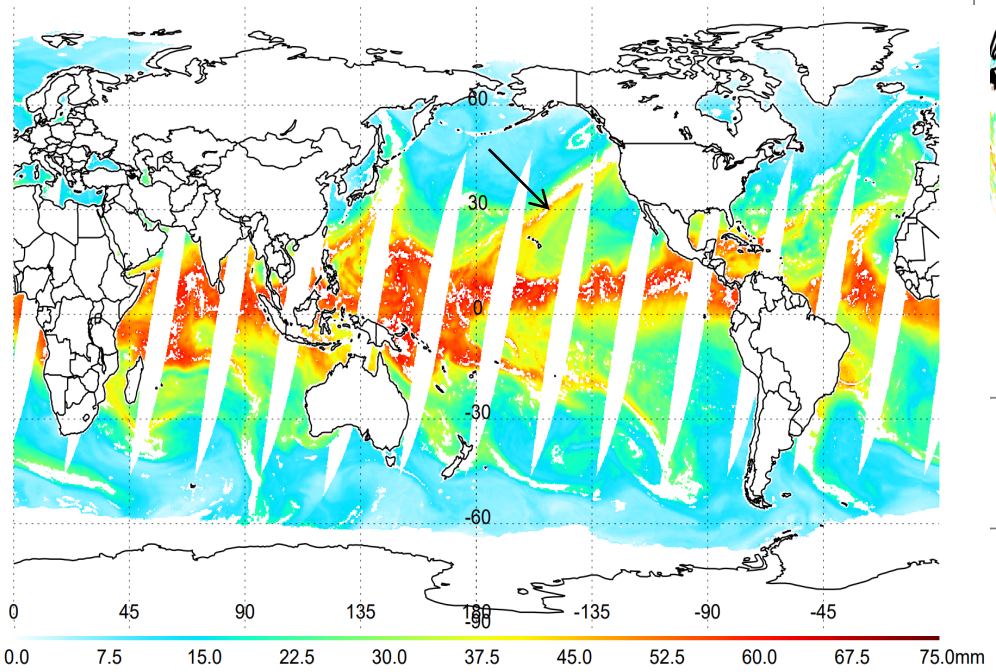
OMI TCWV



Atmospheric River (AR)

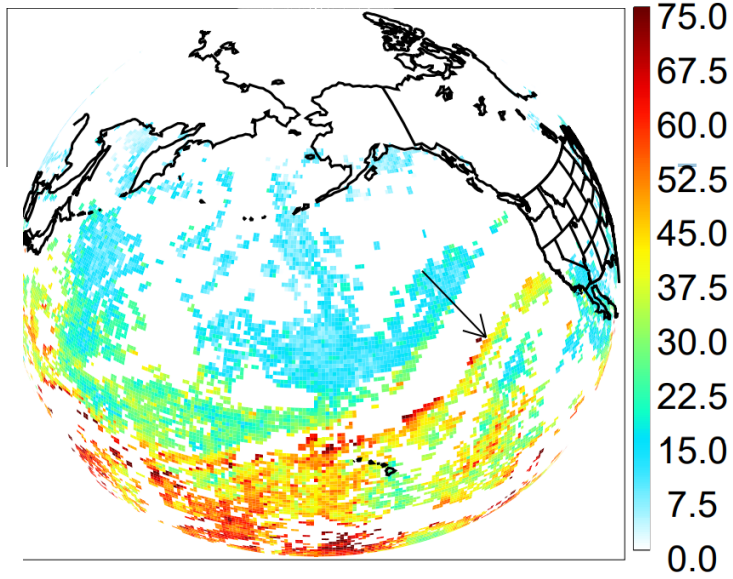
November 6, 2006

SSMIS TCWV (mm)

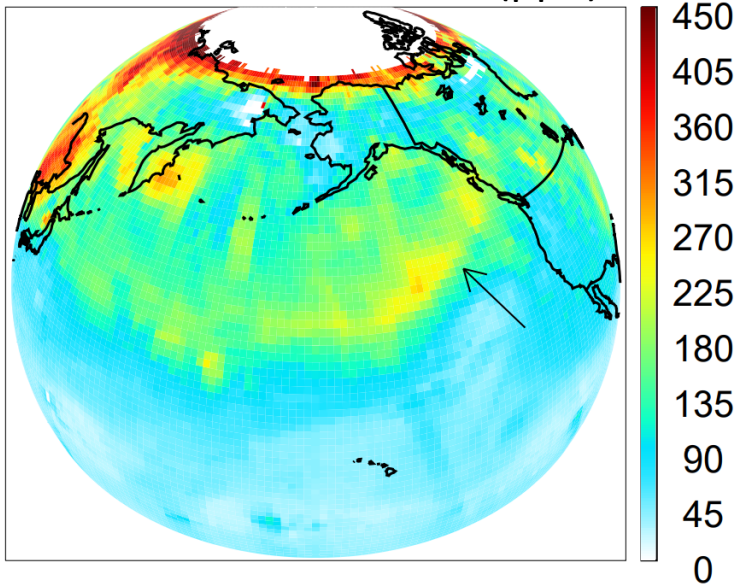


Remote Sensing Systems

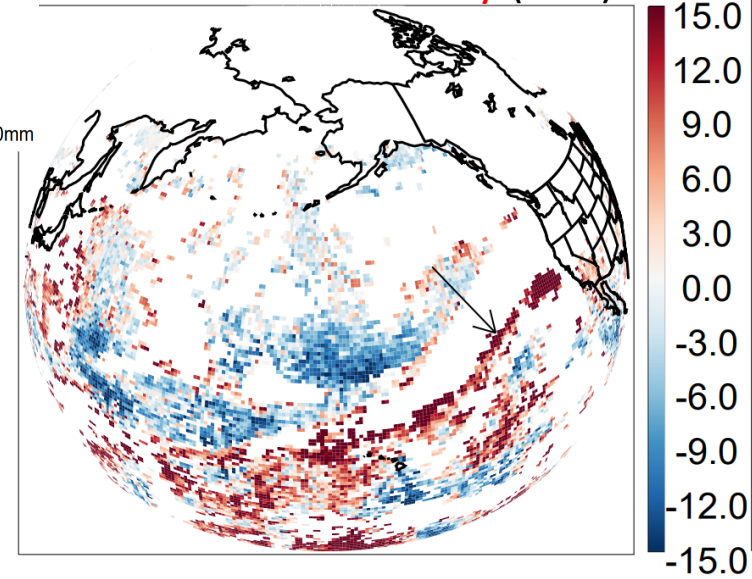
OMI TCWV (mm)



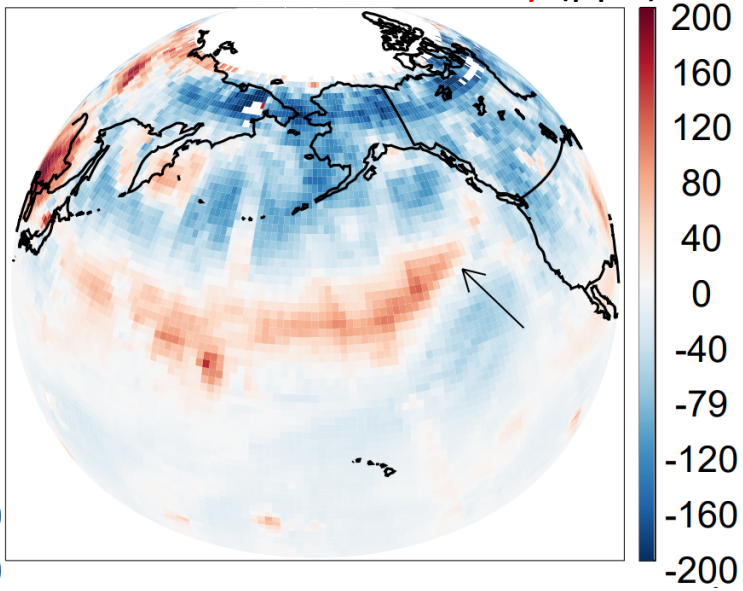
OMI 200mb **Ozone** (ppb)



OMI **TCWV** Anomaly (mm)

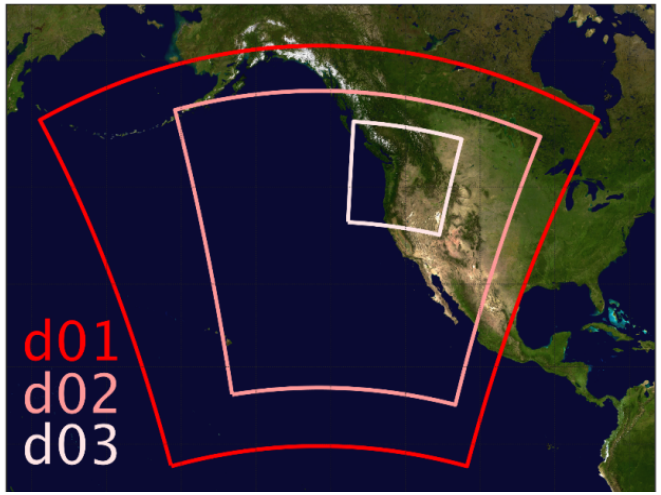


OMI 200mb **Ozone** Anomaly (ppb)

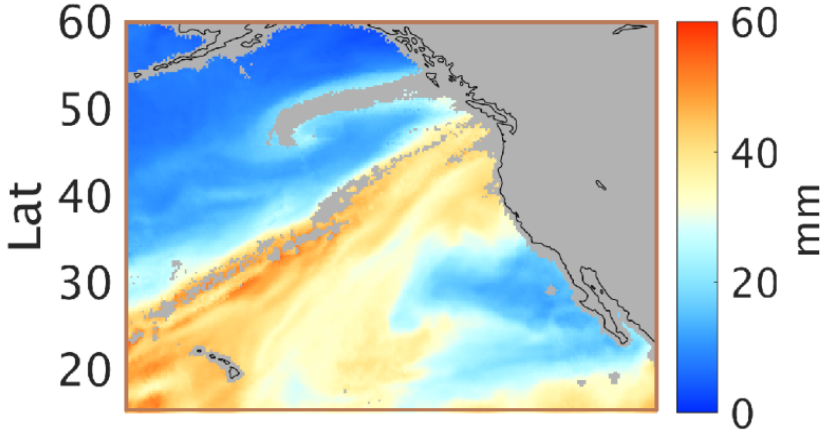


AR accounts for >90% of meridional water vapor transport [Zhu and Newell, 1998]

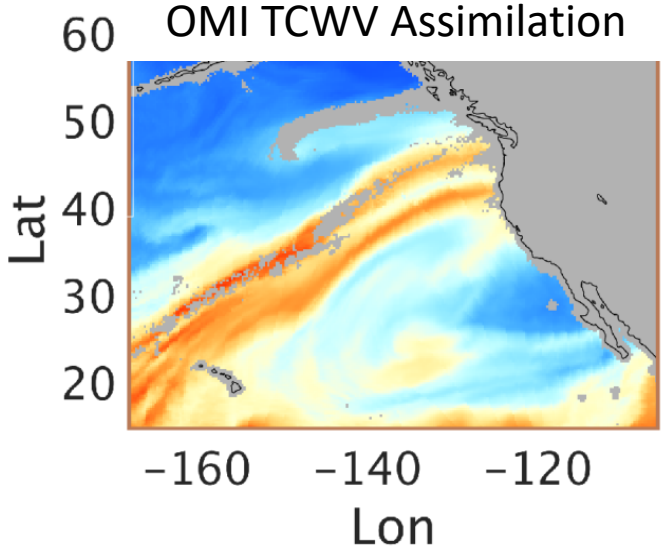
20061106 AR OMI TCWV Assimilation



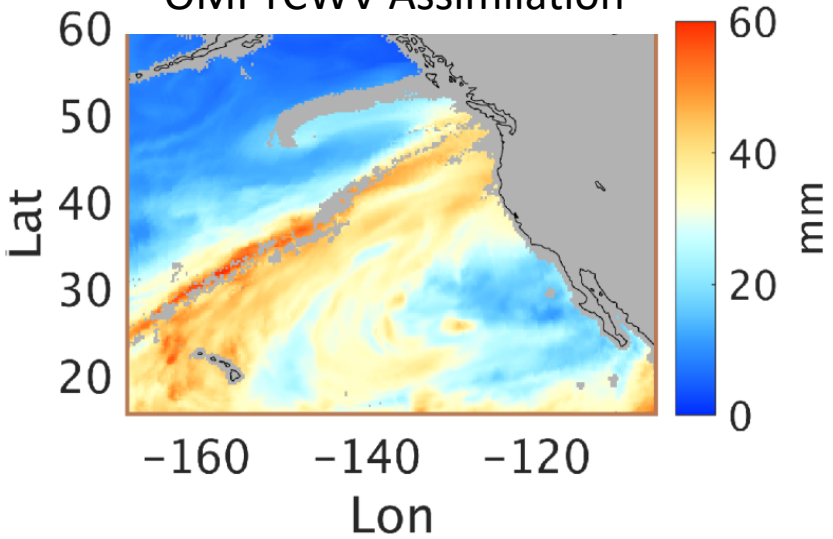
SSMI TCWV



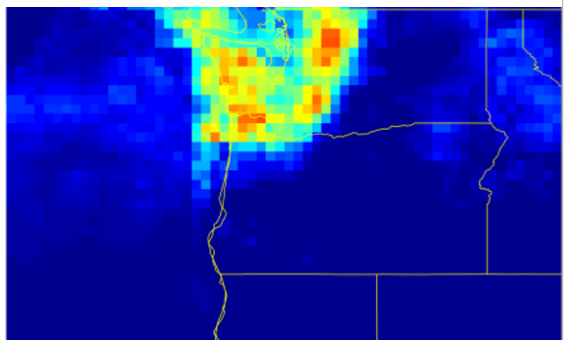
WRF TCWV without OMI TCWV Assimilation



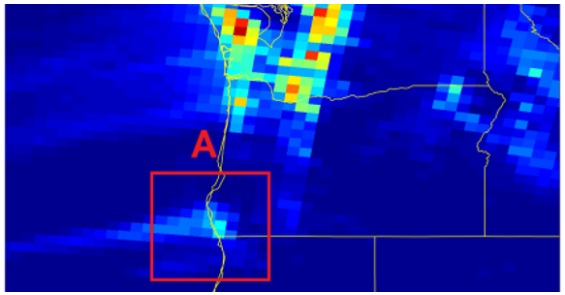
WRF TCWV with OMI TCWV Assimilation



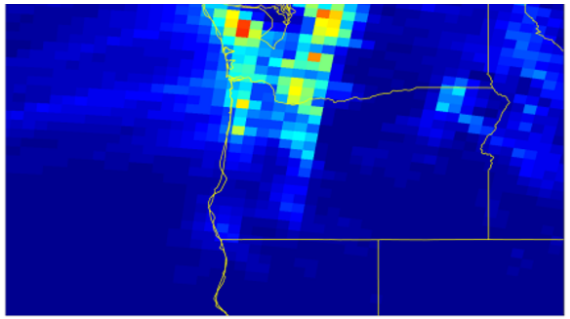
TRMM rain observation



WRF rain without OMI TCWV assimilation



WRF rain with OMI TCWV assimilation



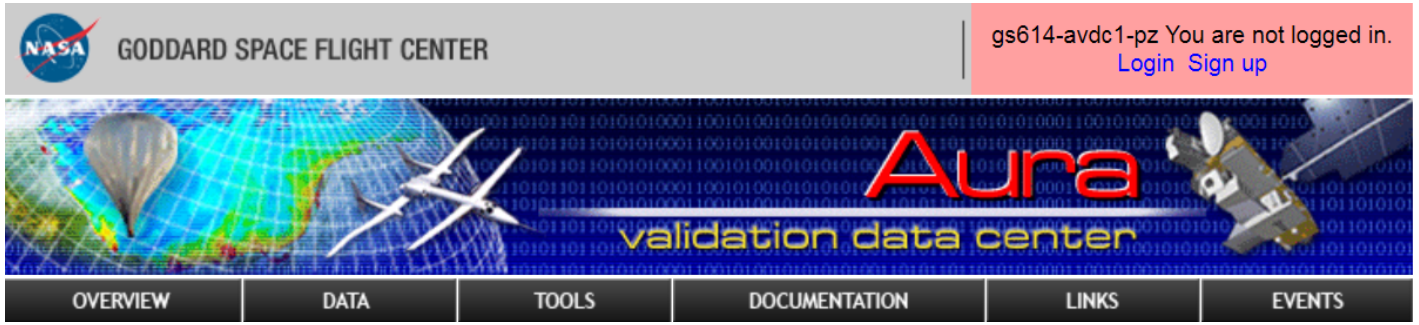
OMI TCWV data can provide useful constraint for weather prediction

Acknowledgement

Funding is provided by NASA Grant NNX17AH47G

- Atmospheric Composition: Aura Science Team and Atmospheric Composition Modeling and Analysis Program

Level 2 OMH2O: V4



- Earth System Data Records of TCWV from 1995:

GOME, SCIAMACHY, GOME-2, OMI, TROPOMI, TEMPO, …