Regional O3 OSSEs

Brad Pierce (NOAA)

GEOCAPE Regional and Urban OSSE WG members

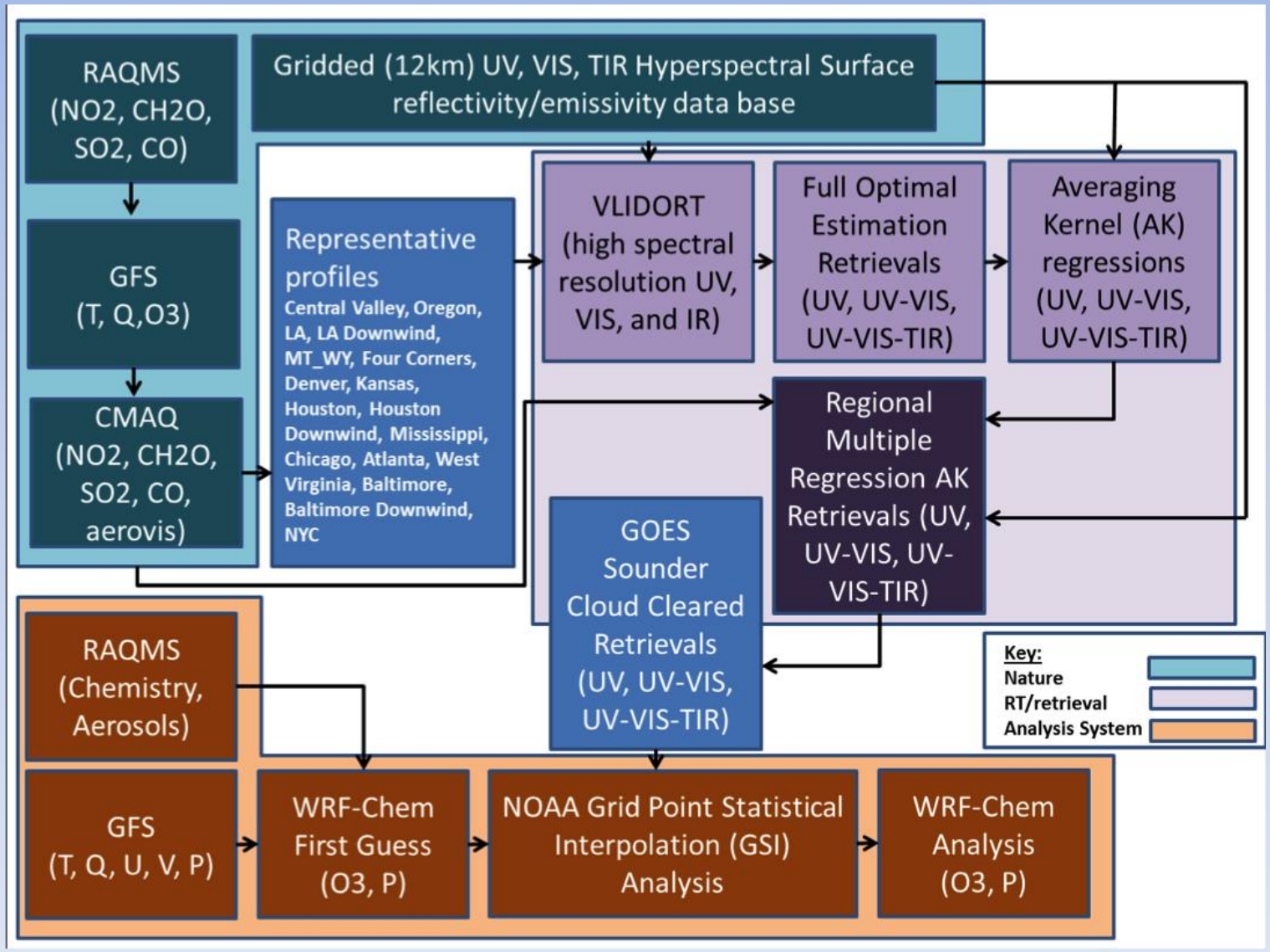
- Co-Leads: Brad Pierce (**NOAA**) and Vijay Natraj (**JPL**)
- Regional Nature run: Brad Pierce and Allen Lenzen (**CIMSS**)
- Forward modeling: Vijay Natraj, Susan Kulawit, (**JPL**)
- Urban Nature run: Ken Pickering and Chris Loughner (**NASA/GSFC**)
- Averaging Kernel regression development: Helen Worden (**NCAR**)

*Additional contributions from Jerome Vidot (**Meteo/France**) and Eva Borbas (**UW-Madison/SSEC**) who have provided the WG with the High Spectral Resolution (HSR) IR emissivity and VIS reflectivity data bases for the OSSE studies.*

GEOCAPE O3 OSSE Goals
July 2011 DISCOVER-AQ Period

- Utilize independent modeling systems for generation of Nature atmosphere and conducting assimilation impact experiments
- Account for realistic atmospheric variability, which requires evaluation of the nature runs with respect to observations
- Include realistic variability in the synthetic radiances, which requires using realistic albedos and emissivities
- Include realistic sensitivities, which requires generation of averaging kernels (AK) for each retrieval for use in assimilation studies

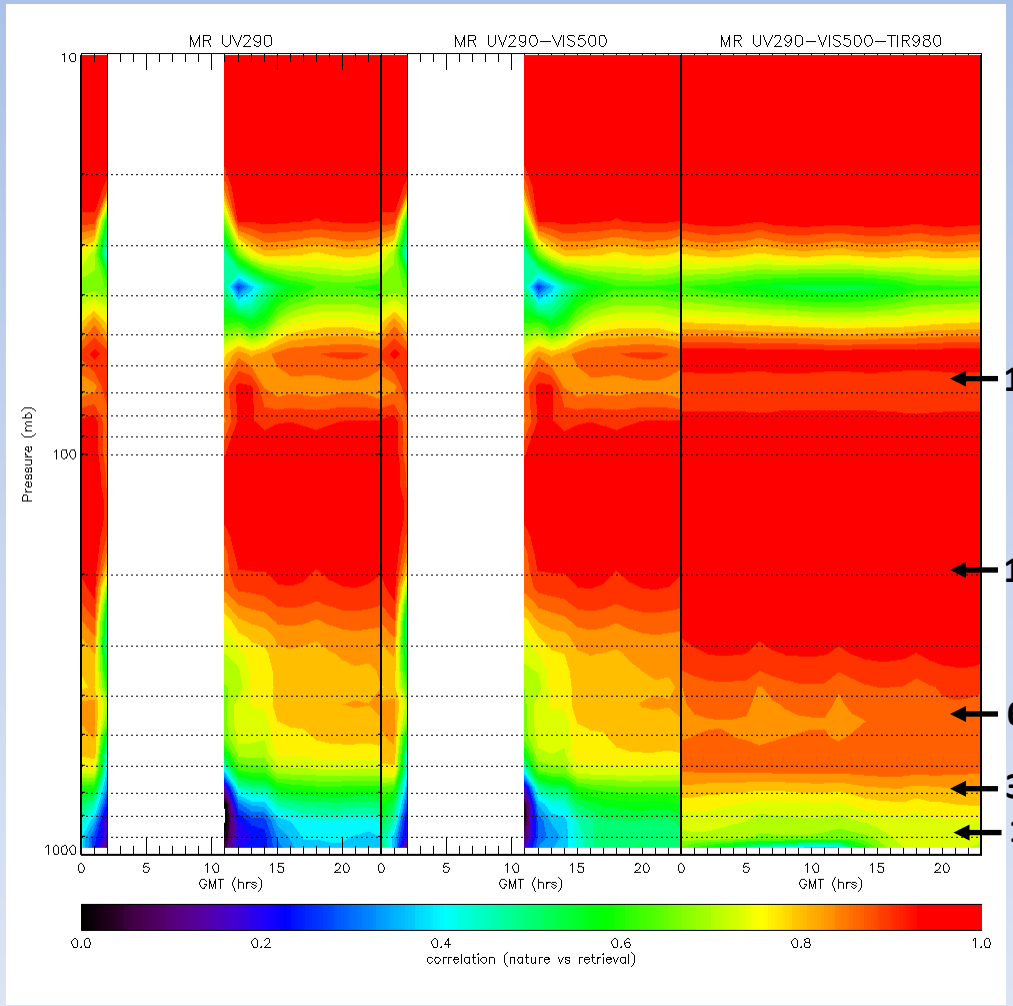
OSSE Flow Chart



Nature/Retrieval Correlations

Regional Multiple Regression AK Retrievals (UV, UV-VIS, UV-VIS-TIR)

- All retrievals show high correlations (>0.9) in upper troposphere/lower stratosphere
- UV-VIS-TIR shows the highest correlations (>0.8) in the mid and lower troposphere
- UV-VIS shows improvement over the UV only retrievals below 800mb

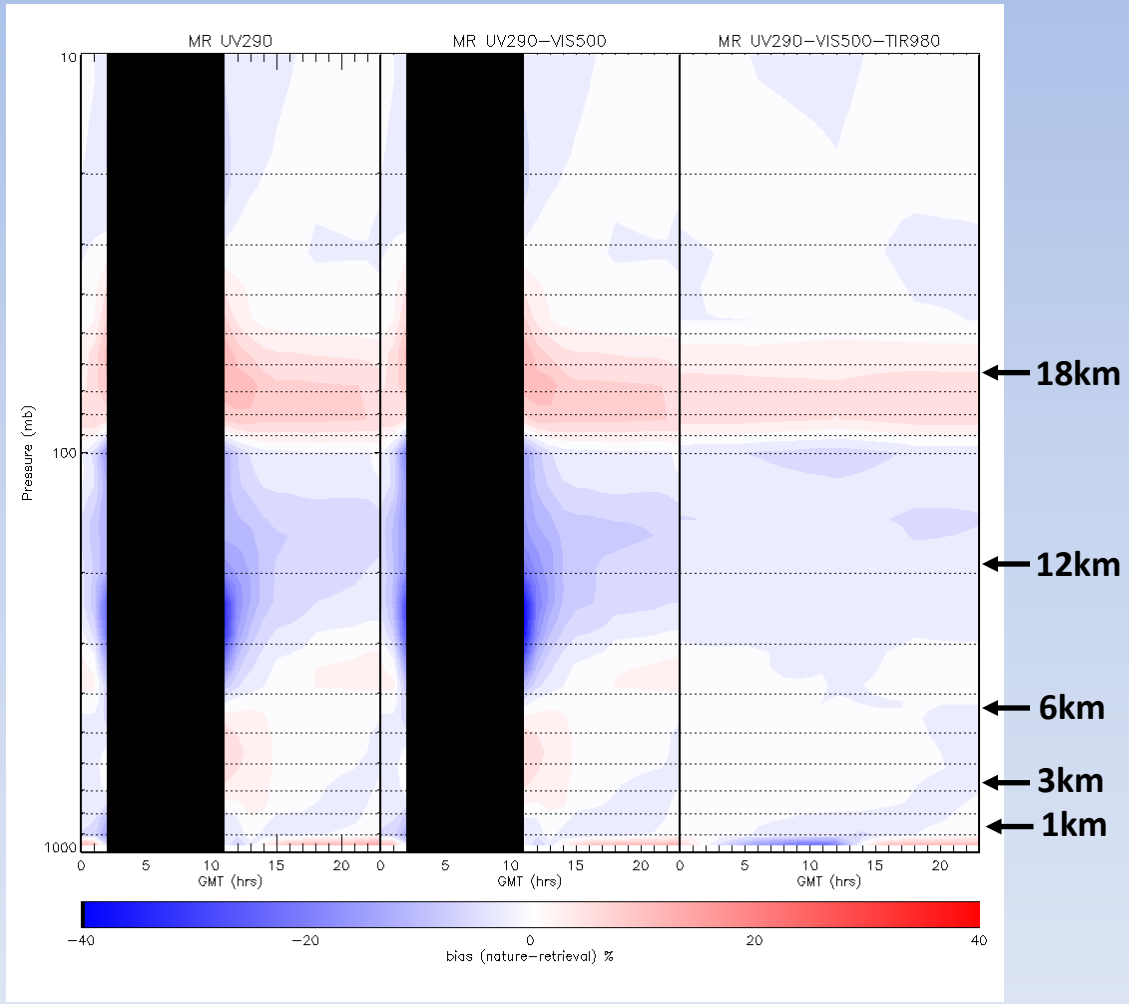


Nature/Retrieval Biases

Regional Multiple Regression AK Retrievals (UV, UV-VIS, UV-VIS-TIR)

Generally low biases (<20%) except:

- between 200-400mb at sunrise and sunset (UV and UV-VIS only)
- Below 900mb (underestimate daytime and overestimate nighttime O3)



July 2011 WRF-CHEM/GSI OSSE Experiments

- Synthetic OMI (using actual retrieval efficiency factors and apriori)

- OMI+ Multiple Regression GEOCAPE UV-VIS-TIR synthetic retrievals
- OMI+ Multiple Regression GEOCAPE UV-VIS synthetic retrievals
- OMI+ Multiple Regression GEOCAPE UV synthetic retrievals

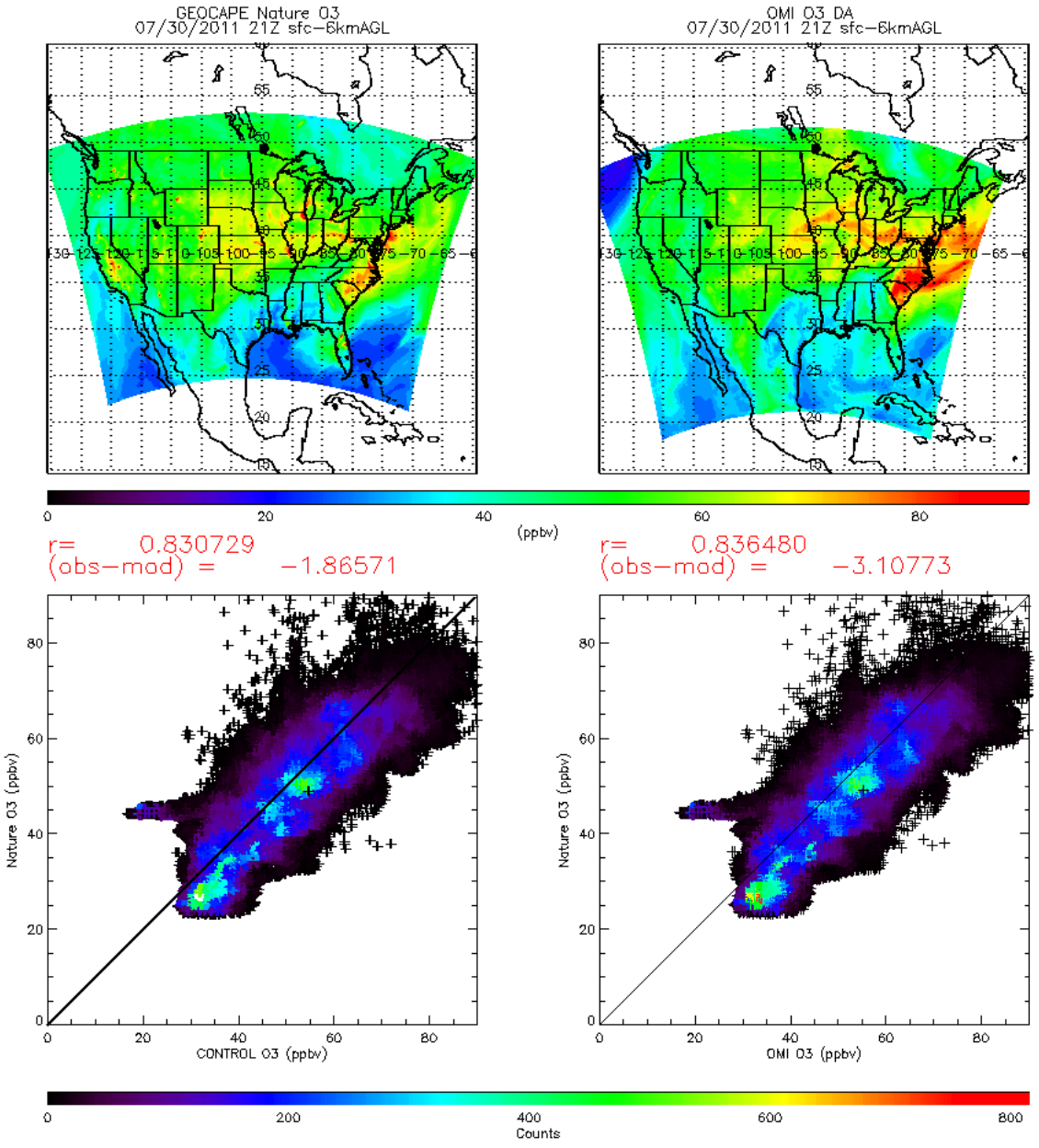
- Multiple Regression GEOCAPE UV-VIS-TIR synthetic retrievals
- Multiple Regression GEOCAPE UV-VIS synthetic retrievals
- Multiple Regression GEOCAPE UV synthetic retrievals

All OSSE experiments include:

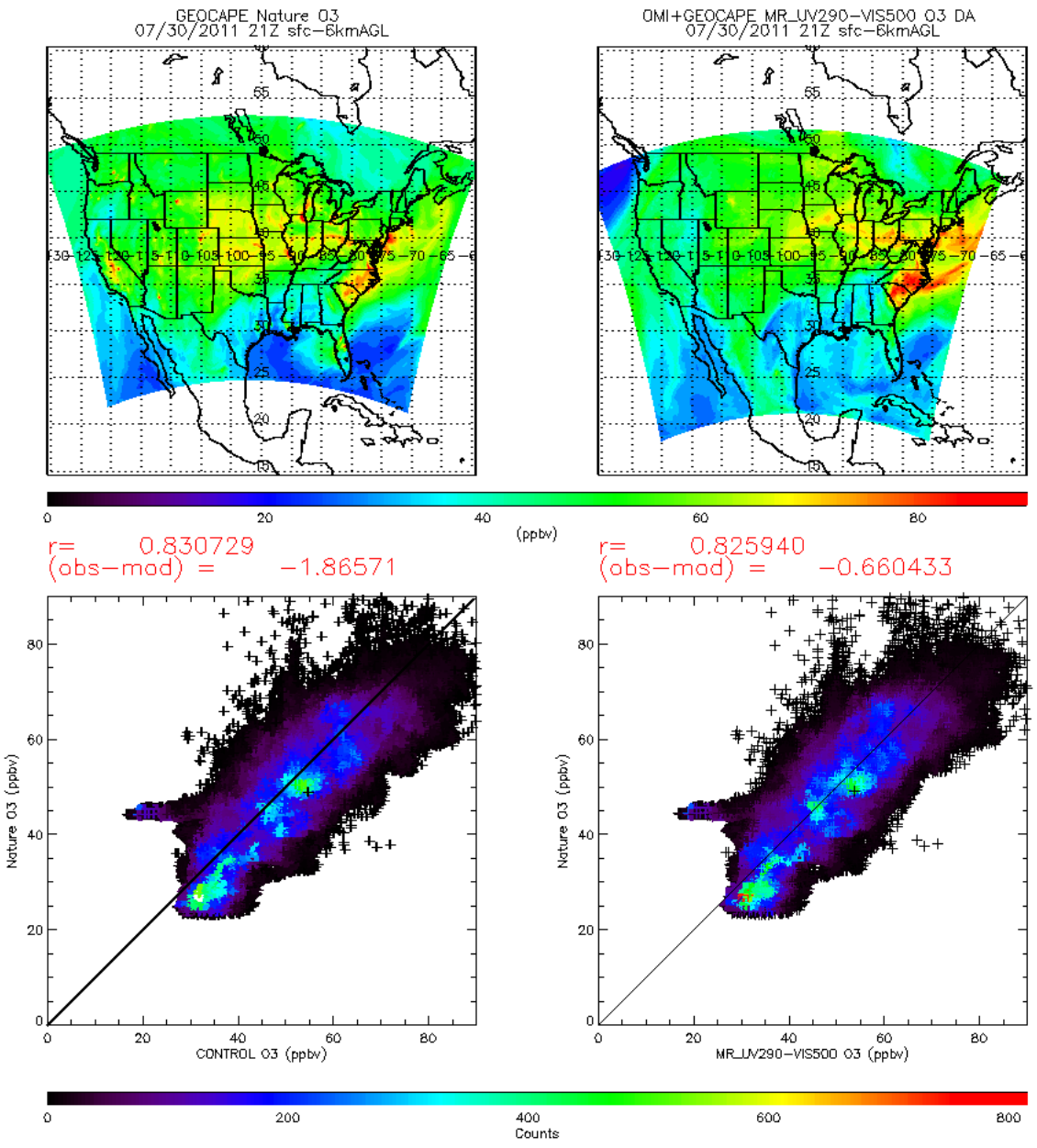
- ❑ 1 hour cycling
- ❑ Inflation of background error covariances near surface
- ❑ Application of linear observation operator (AK) in GSI enter loop
  - ✓ *needed for stability during initial large UTLS adjustments*

Results compared to nature run integrated over atmospheric layers (12-18km, 6-12km, 0-6km, 0-3km, 0-1km)

sfc-6km Nature vs OMI DA 21Z 07/30/2011



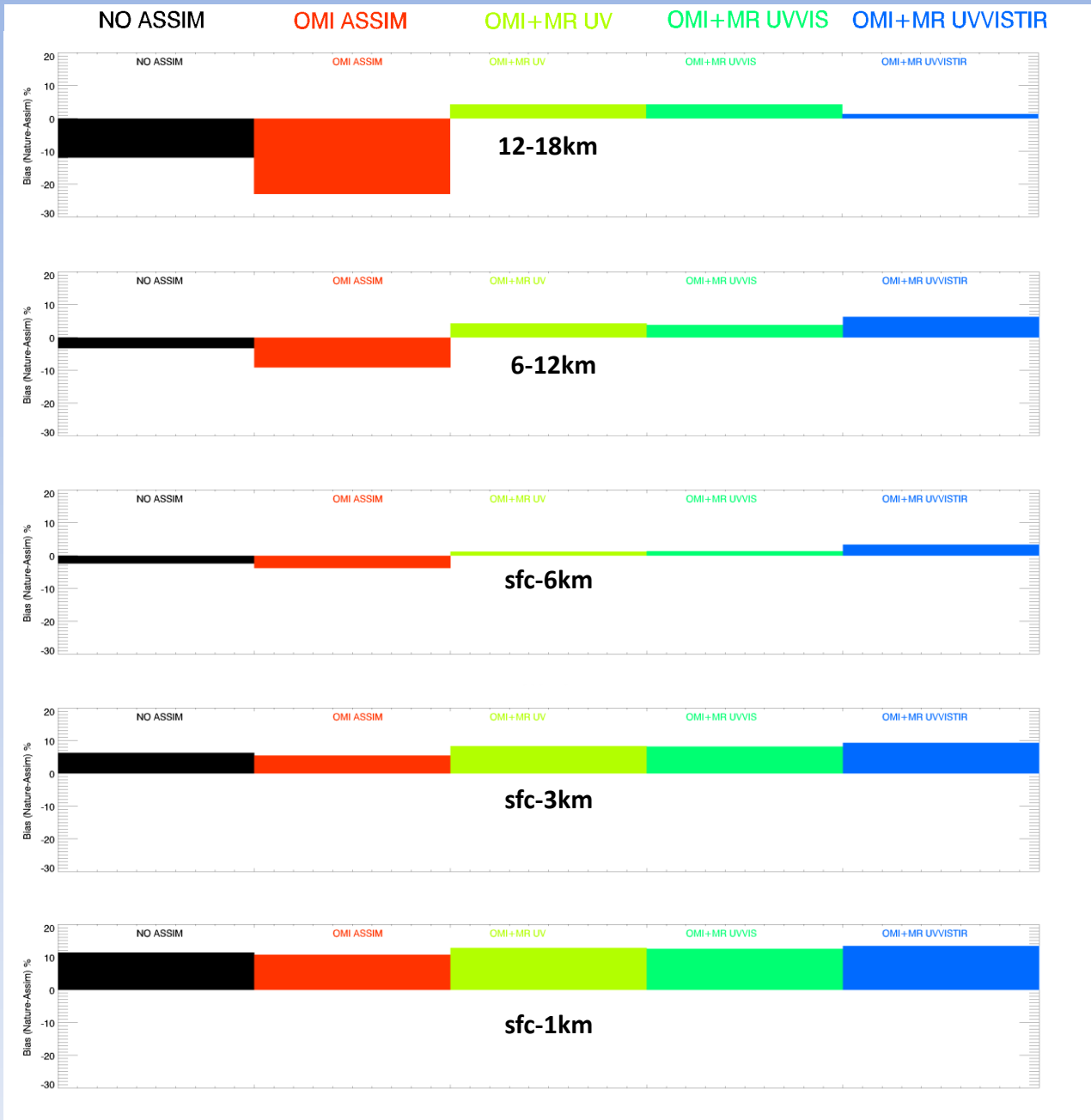
sfc-6km Nature vs OMI+UVVIS DA 21Z 07/30/2011



OMI+MR OSSE results

- Significant reductions in high biases introduced by OMI for all MR retrievals except the surface-1km and surface-3km layers
- OMI+MR UV and OMI+MR UVVIS show similar results
- OMI+UVVISTIR shows lower biases between 12-18km but larger biases then UV or UVVIS below 12km

Diurnal Averaged Bias



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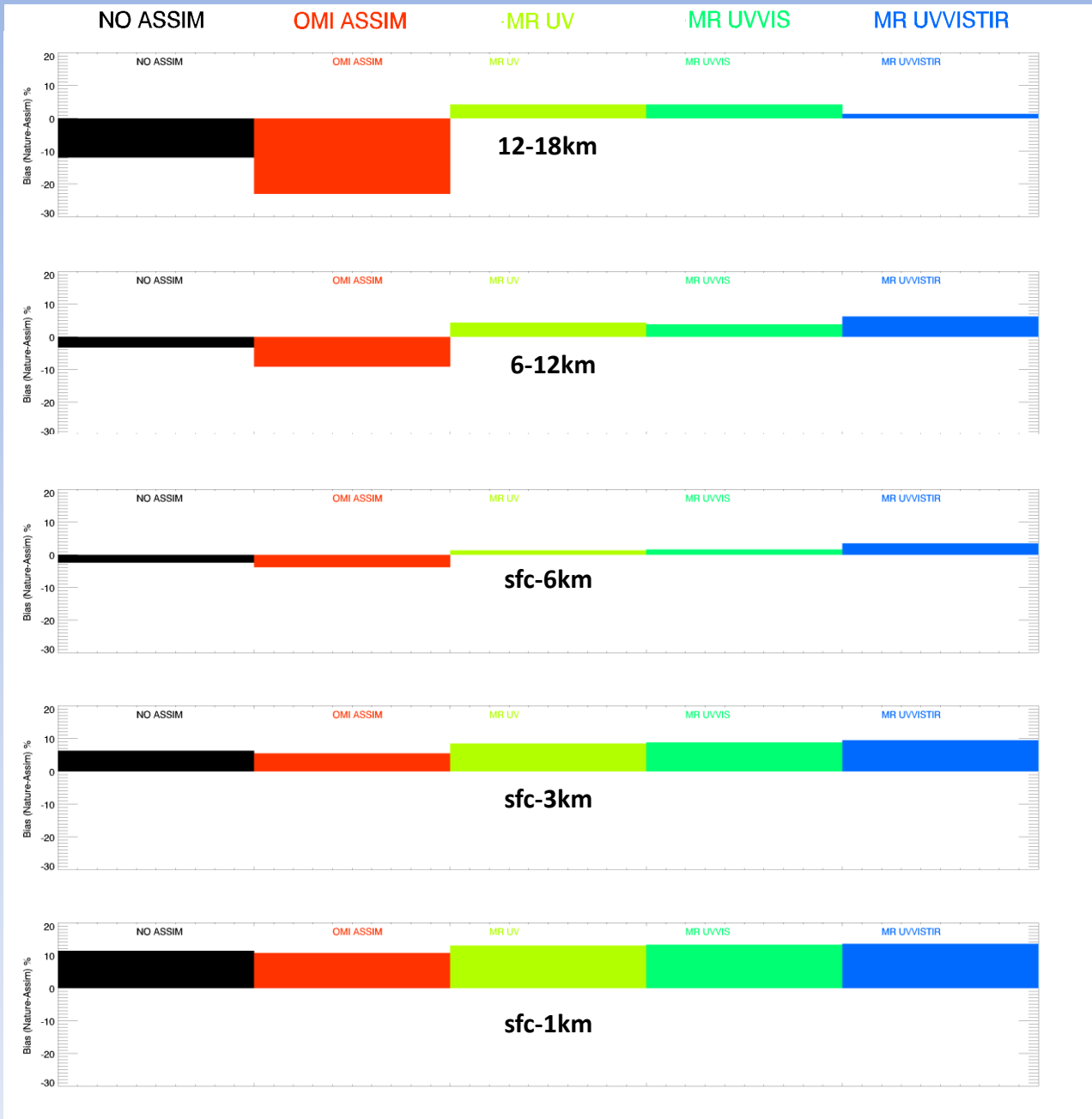
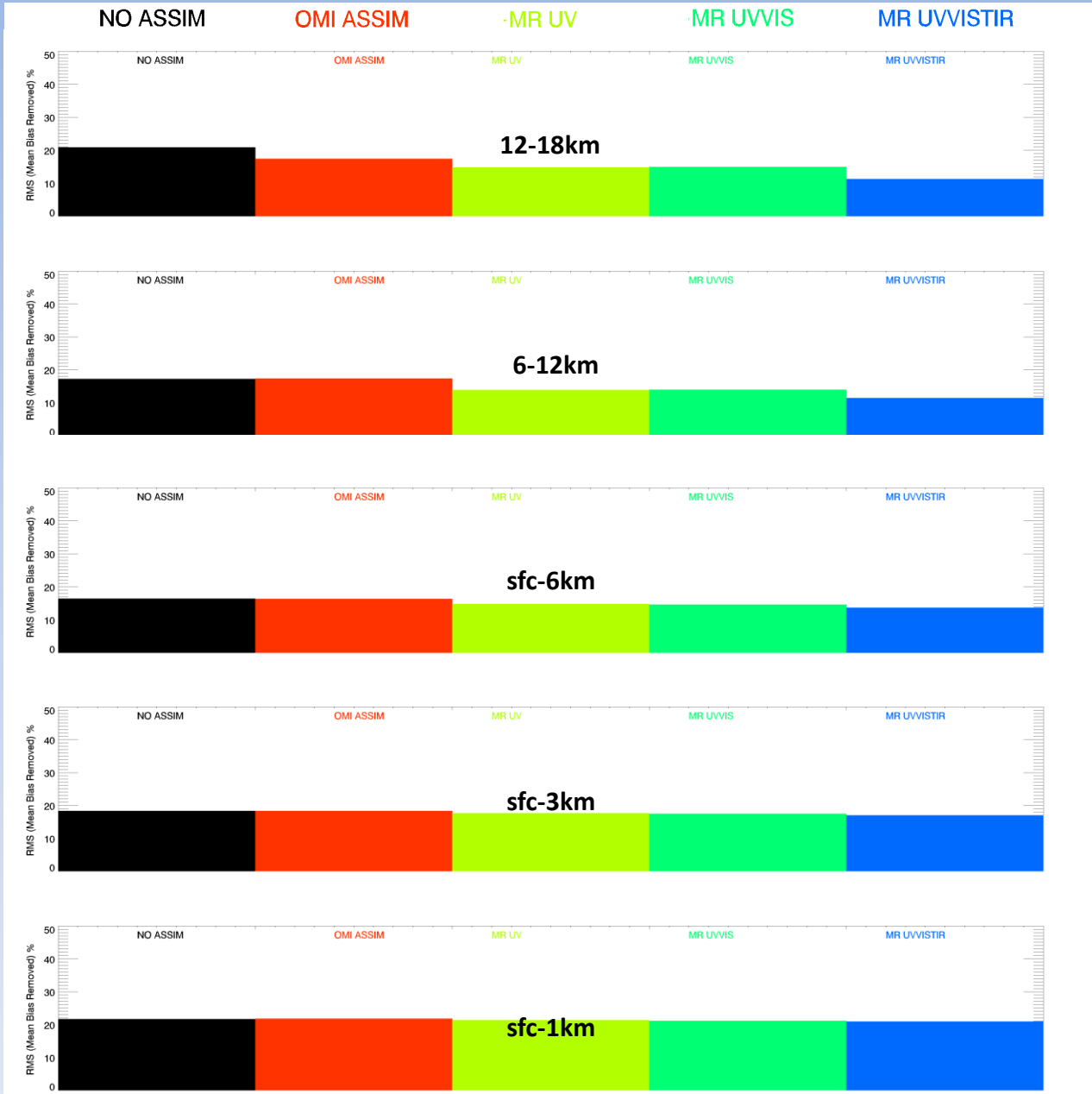


MR OSSE results

- Slight improvements in RMS error over OMI for all MR retrievals except the surface-1km layer
- OMI+MR UV and OMI+MR UVVIS show similar results
- OMI+UVVISTIR shows largest improvements

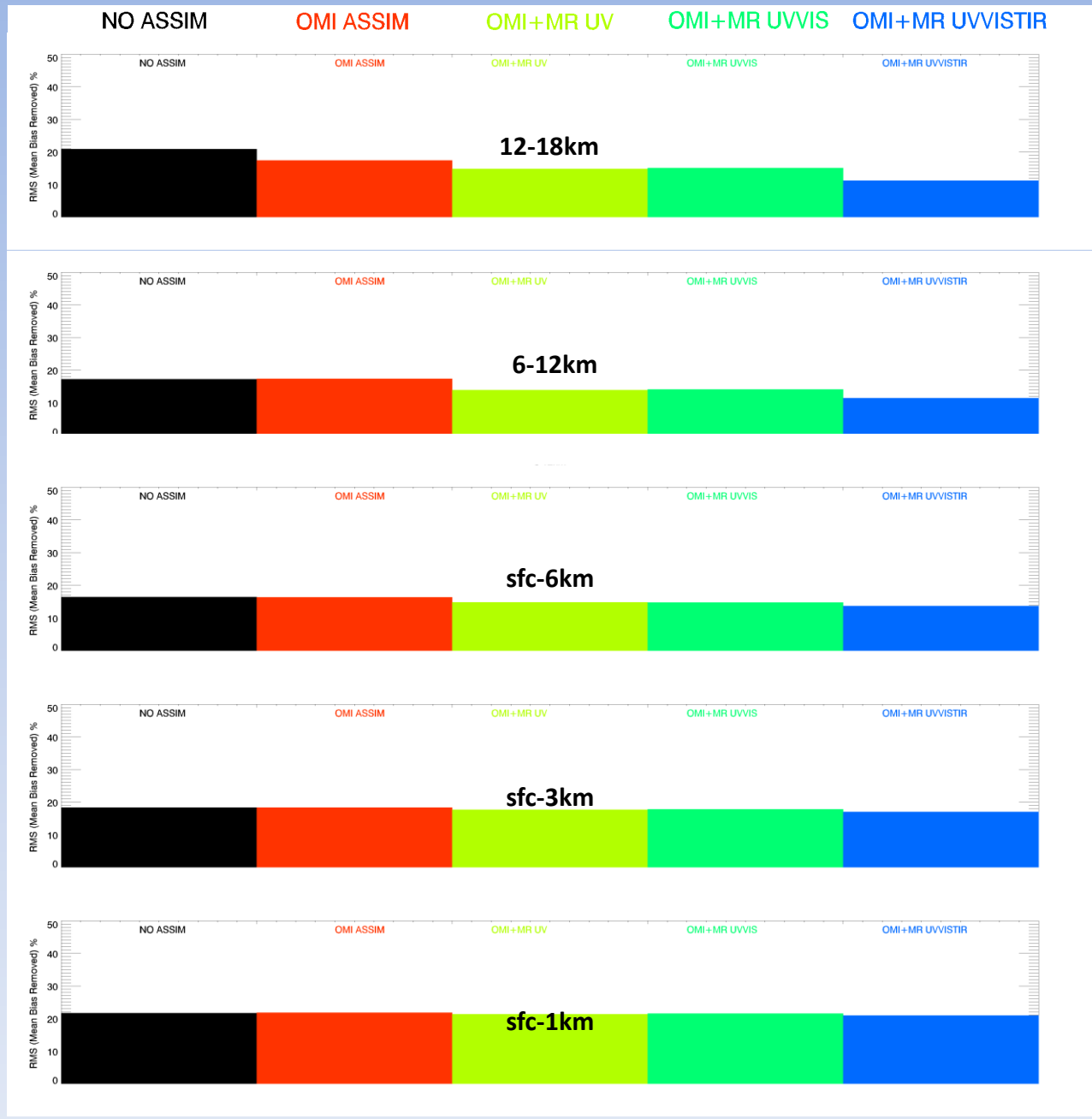
Diurnal Averaged RMS Error



OMI+MR OSSE results

- Slight improvements in RMS error over OMI only for all MR retrievals
- OMI+MR UV and OMI+MR UVVIS show similar results
- OMI+UVVISTIR shows largest improvements

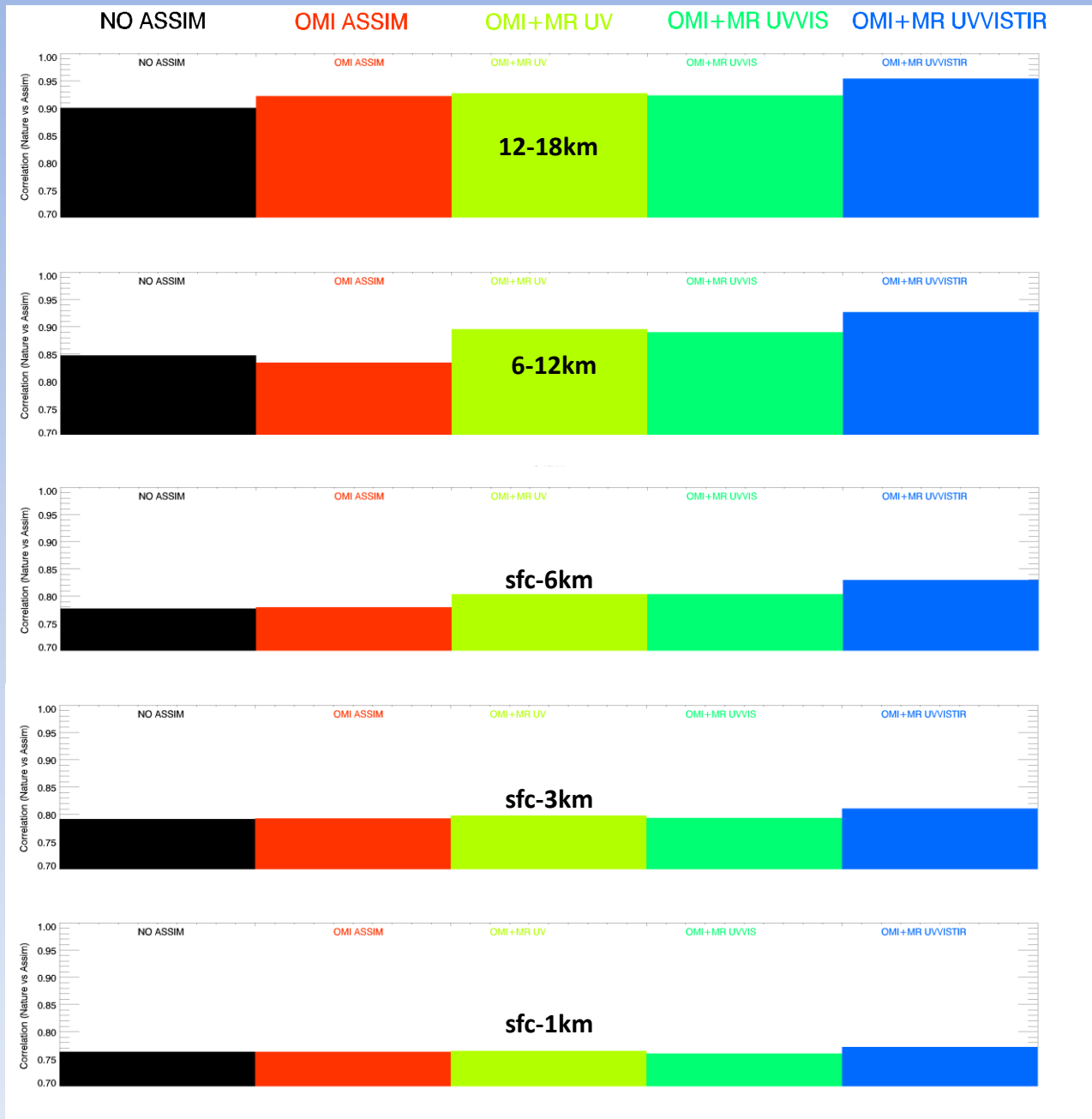
Diurnal Averaged RMS Error



OMI+MR OSSE results

- Slight improvements in correlation over OMI only for all MR retrievals
- OMI+MR UV and OMI+MR UVVIS show similar results
- OMI+UVVISTIR shows largest improvements

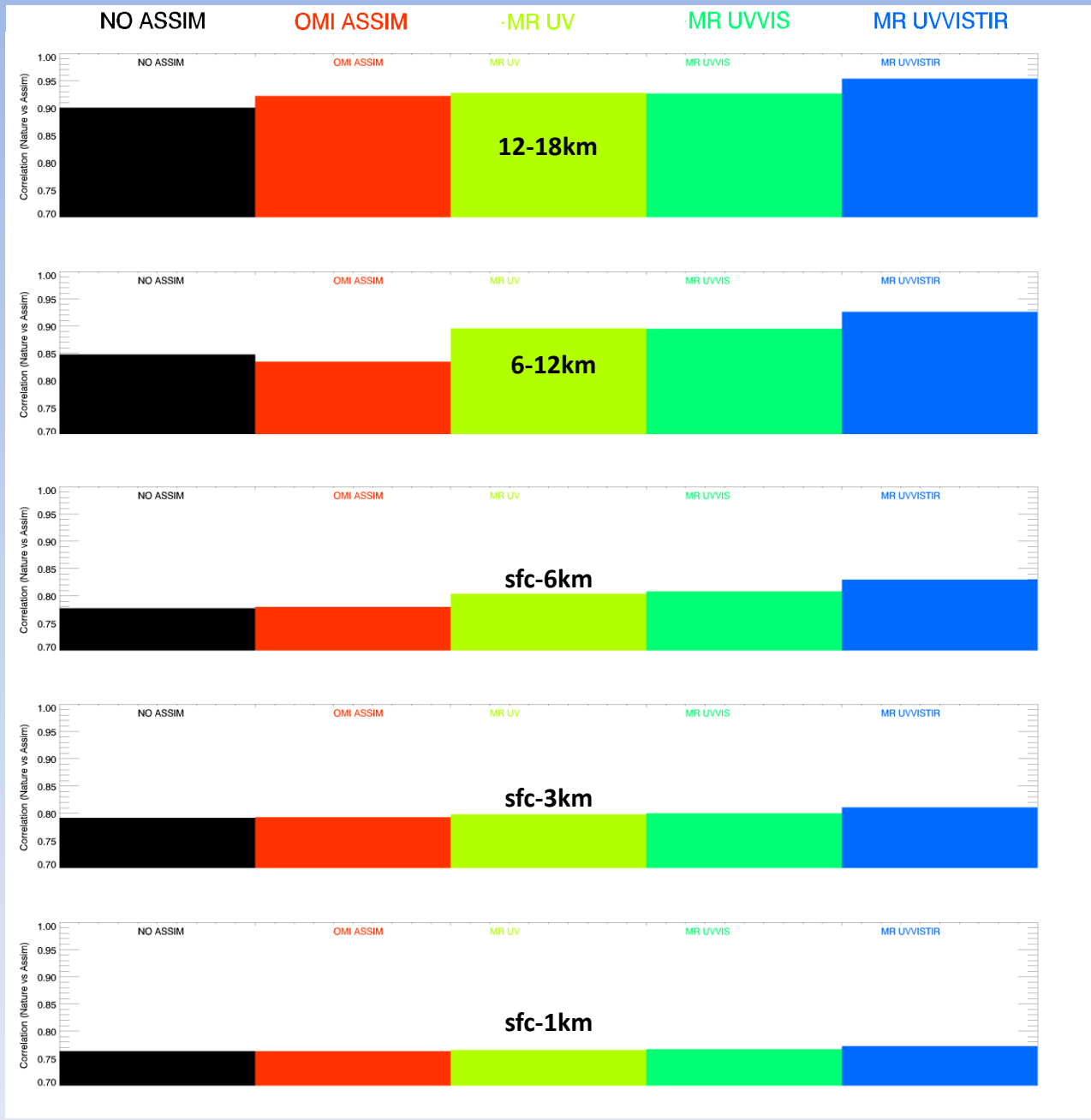
Diurnal Averaged Correlation



MR OSSE results

- Slight improvements in correlation over OMI for all MR retrievals
- MR UV and UVVIS retrievals show similar results
- OMI+UVVISTIR shows largest improvements

Diurnal Averaged Correlation



Summary

•Hourly geostationary UV, UVVIS, and UVVISTIR ozone retrievals show high correlations with nature run (>0.8) except for sunrise/sunset UV and UVVIS retrievals and below 700mb (3km)

•Hourly geostationary UV, UVVIS, and UVVISTIR ozone retrievals show fairly low biases relative to nature run (<20%) except for sunrise/sunset UV and UVVIS retrievals and below 900mb (1km)

•Assimilation of hourly geostationary UV, UVVIS and UVVISTIR ozone retrievals improves correlation, rms error and bias relative to control and OMI polar orbit retrievals in the upper troposphere lower stratosphere (12-18km), middle troposphere (6-12km) and lower troposphere (0-6km)

•Surface-1km and surface-3km layers show neutral results for correlation and rms errors and slight increases in diurnally averaged biases when hourly geostationary UV, UVVIS, and UVVISTIR ozone retrievals are assimilated.

•These WRF-CHEM/GSI results suggest that it will be difficult to obtain improvements in boundary layer ozone analyses through 3D variational assimilation of geostationary ozone retrievals alone due to the strong dependence on ozone precursor emissions.