Some Thoughts on Transitioning to NPP

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Issues

Continuing MODIS through NPP/NPOESS and beyond

Preparing for VIIRS
- participation in VIIRS OAT
- P3I

Assuring viable Cal/Val
- Planning evolution of MAS
- VIIRS Airborne Simulator

NPOESS Products

(NPOESS IORD Environmental Data Records by Instrument)

- ★ Atmospheric Vertical Moisture Profile
- ★ Atmospheric Vertical Temperature Profile
- ★ Imagery
- ★ Sea Surface Temperature
- ★ Sea Surface Winds
- ★ Soil Moisture
- Aerosol Optical Thickness
- Aerosol Particle Size
- Albedo (Surface)
- Auroral Boundary
- Auroral Imagery
- Cloud Base Height
- Cloud Cover/Layers
- Cloud Effective Particle Size
- Cloud Ice Water Path
- Cloud Liquid Water
- Cloud Optical Depth/Transmittance
- Cloud Top Height
- Cloud Top Pressure
- Cloud Top Temperature
- Currents (Ocean)

- Downward Longwave Radiance (Sfc)
- Electric Fields
- Electron Density Profile
- Energetic Ions
- Fresh Water Ice
- Geomagnetic Field
- Ice Surface Temperature
- In-situ Plasma Fluctuations
- In-situ Plasma Temperature
- Insolation
- Ionospheric Scintillation
- Medium Energy Charged Particles
- Land Surface Temperature
- Littoral Sediment Transport
- Mass Loading / Turbidity
- Net Heat Flux
- Net Short Wave Radiance (TOA)
- Neutral Density Profile
- Neutral Winds
- Ocean Color/Chlorophyll
- Ocean Wave Characteristics

- Ozone - Total Column/Profile
- Precipitable Water
- Precipitation Type/Rate
- Pressure (Surface/Profile)
- Sea Ice Age and Ice Edge Motion
- Sea Surface Height/Topography
- Snow Cover/Depth
- Solar Irradiance
- Supra-Thermal - Auroral Particles
- Surface Type
- Fires
- Surface Wind Stress
- Suspended Matter
- Total Auroral Energy Deposition
- Total Longwave Radiance (TOA)
- Total Water Content
- Vegetation Index (NDVI)

VIIRS | CMIS | CrIS/ATMS | OMPS | SES | GPSOS | ERBS | TSIS | ALT

★ Environmental Data Records (EDRs) with Key Performance Parameters

NPOESS Products

(NPOESS IORD Environmental Data Records by Discipline)

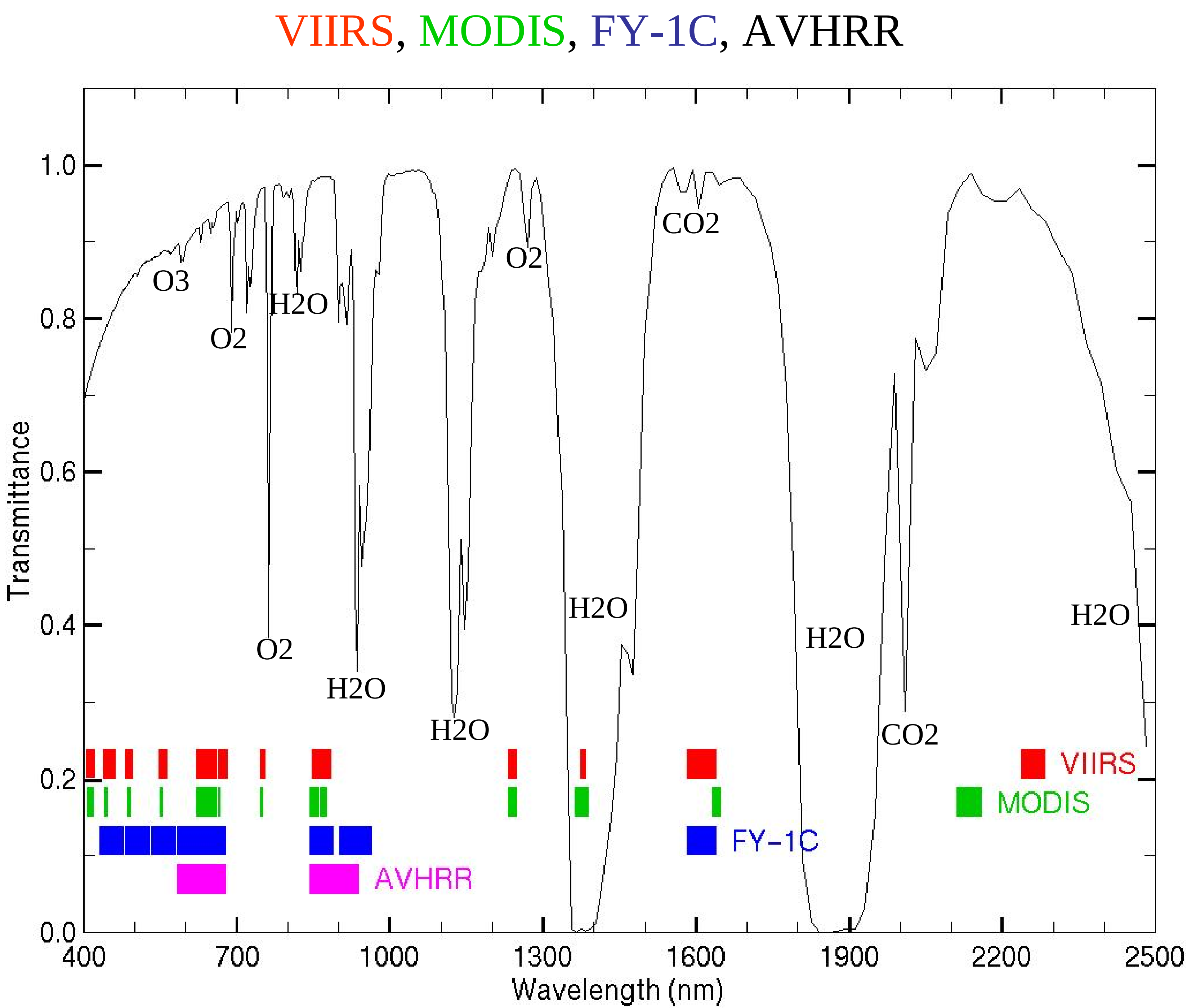
- ★ Atmospheric Vertical Moisture Profile
- ★ Atmospheric Vertical Temp Profile
- ★ Imagery
- ★ Sea Surface Temperature
- ★ Sea Surface Winds
- ★ Soil Moisture
- Aerosol Optical Thickness
- Aerosol Particle Size
- Albedo (Surface)
- Auroral Boundary
- Auroral Imagery
- Cloud Base Height
- Cloud Cover/Layers
- Cloud Effective Particle Size
- Cloud Ice Water Path
- Cloud Liquid Water
- Cloud Optical Depth/Transmittance
- Cloud Top Height
- Cloud Top Pressure
- Cloud Top Temperature
- Currents (Ocean)

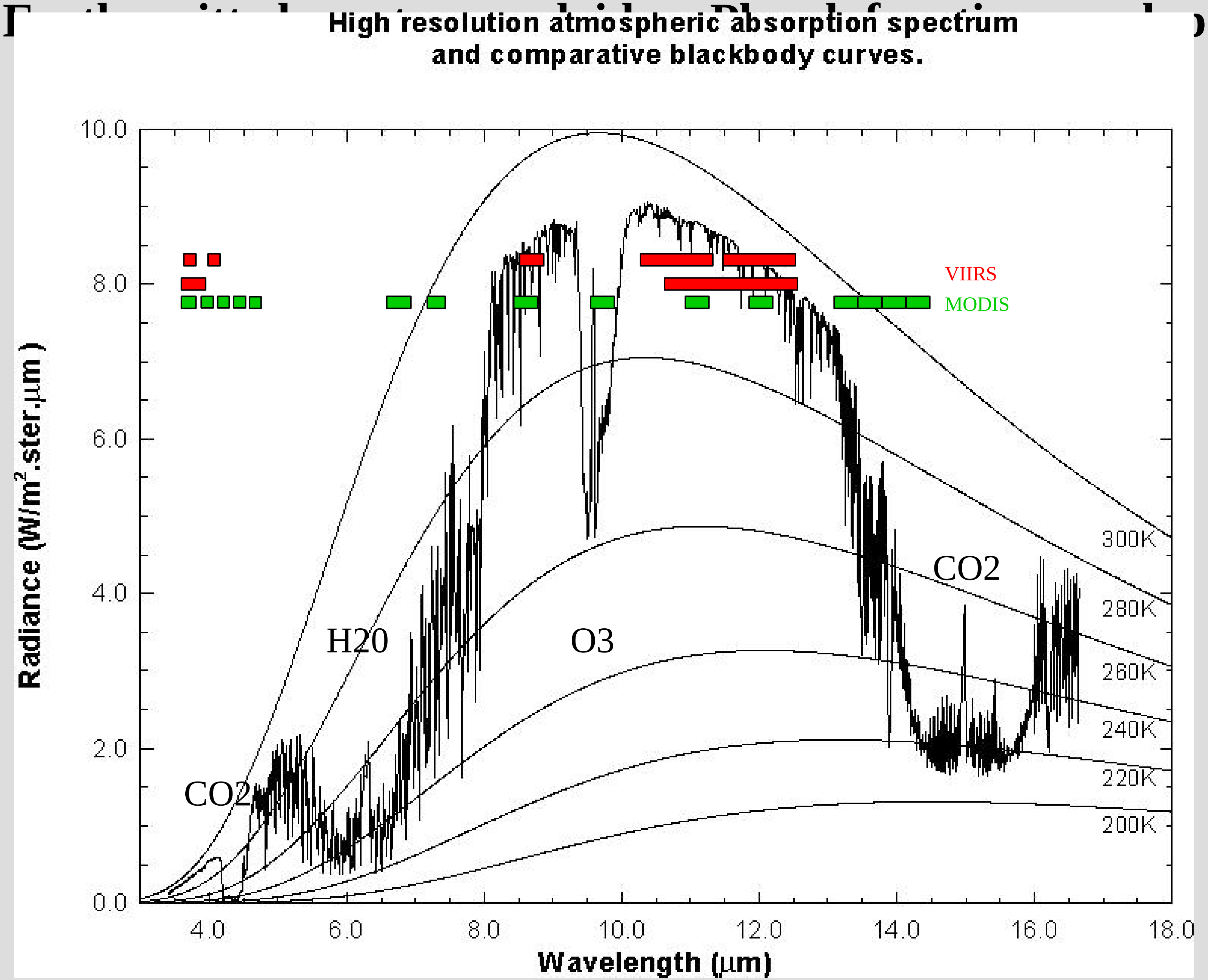
- Downward Longwave Radiance (Sfc)
- Electric Fields
- Electron Density Profile
- Fresh Water Ice
- Geomagnetic Field
- Ice Surface Temperature
- Energetic Ions
- In-situ Plasma Fluctuations
- In-situ Plasma Temperature
- Insolation
- Medium Energy Charged Particles
- Ionospheric Scintillation
- Land Surface Temperature
- Littoral Sediment Transport
- Net Heat Flux
- Net Short Wave Radiance (TOA)
- Neutral Density Profile
- Neutral Winds
- Normalized Difference Vegetation Index
- Ocean Color/Chlorophyll
- Ocean Wave Characteristics

- Ozone - Total Column/Profile
- Precipitable Water
- Precipitation Type/Rate
- Pressure (Surface/Profile)
- Sea Ice Age and Edge Motion
- Sea Surface Height/Topography
- Snow Cover/Depth
- Solar Irradiance
- Supra-Thermal - Auroral Particles
- Surface Wind Stress
- Suspended Matter
- Total Auroral Energy Deposition
- Total Longwave Radiance (TOA)
- Total Water Content
- Turbidity
- Vegetation Index/Surface Type

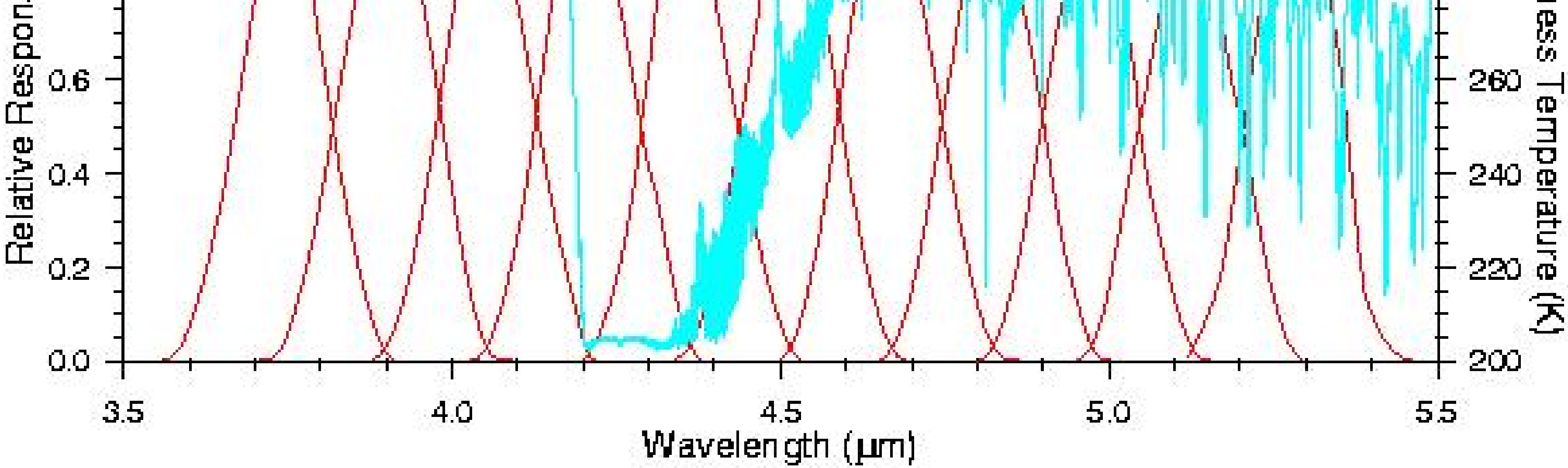
Atmospheric | Oceanic | Terrestrial | Space | Climate

★ Environmental Data Records (EDRs) with Key Performance Parameters

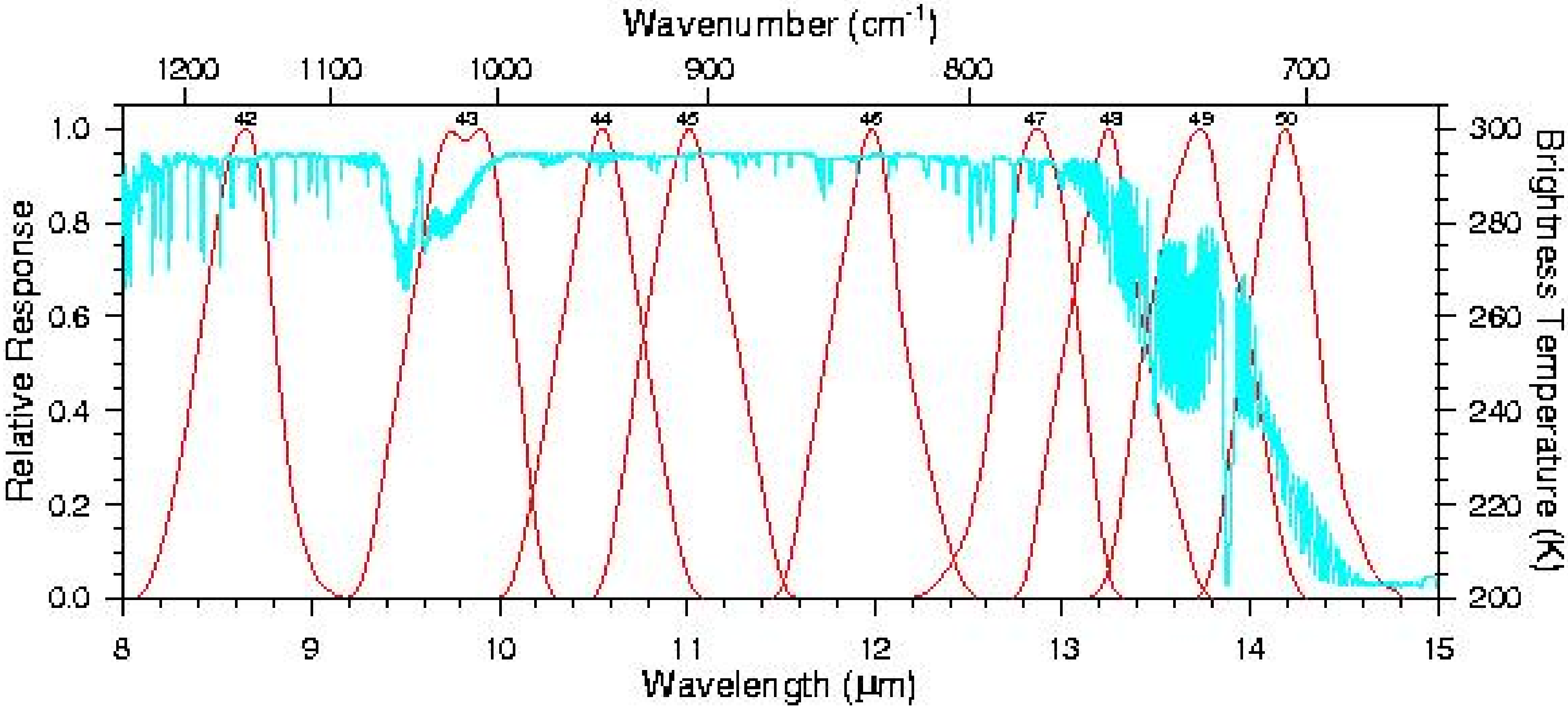

VIIRS, MODIS, FY-1C, AVHRR
Transmittance
Wavelength (nm)
1.0
0.8
0.6
0.4
0.2
0.0
400
700
1000
1300
1600
1900
2200
2500
O3
O2
H2O
O2
H2O
H2O
O2
H2O
CO2
H2O
CO2
H2O
VIIRS
MODIS
FY-1C
AVHRR


High resolution atmospheric absorption spectrum
and comparative blackbody curves.
Radiance (W/m2.ster.μm)
Wavelength (μm)
10.0
8.0
6.0
4.0
2.0
0.0
4.0
6.0
8.0
10.0
12.0
14.0
16.0
18.0
VIIRS
MODIS
300K
280K
260K
240K
220K
200K
CO2
H20
O3
CO2

Planning the VIIRS Airborne Simulator



Relative Respons
Wavelength (μm)
Brightness Temperature (K)



Wavenumber (cm⁻¹)
42
43
44
45
46
47
48
49
50
Relative Response
Brightness Temperature (K)
Wavelength (μm)

VIIRS Airborne Simulator (VAS) Concept

Rationale:

- Collect high-resolution, calibrated data to validate the on-orbit performance and calibration of the VIIRS instrument

- Build a feature-rich VIIRS-like data set for the development and test of CDR and EDR product algorithms, prior to NPP/NPOES launch

Approach:

- Capitalize on the NASA MODIS and ASTER Airborne Simulator Programs (MAS and MASTER) and U.W. S-HIS experience

- Leverage ongoing development programs for accelerated deployment

- Apply MAS “lessons-learned” and operational experience for risk reduction.

MAS Lessons

- Spectral stability is critical for atmospheric bands
- Flat-plate blackbody design not capable of <1 degree accuracy
- Cross-track polarization needs to be addressed
- Onboard calibrator for Vis/SWIR bands highly desirable
- Scattered light inside scan cavity needs to be reduced
- Internal IR background radiation has to be better suppressed
- Replace gratings with bandpass filters for LWIR bands
- Eliminate linear-variable filters (LVFs) from design
- Additional SWIR and LWIR water vapor bands are useful

Design Features

- Single large dewar for LWIR bands and cold secondary optics to reduce background noise
- Filter-based spectral differentiation in M/LWIR bands
- Added 6.7um (and possible 1.88um) band
- Improved blackbody design, based on S-HIS experience
- Visible/SWIR calibrator
- De-polarization methods to be investigated
- Fully supported by Ames Calibration Lab (NIST-traceable)
- Utilize ground-processing and archive software from MAS
  (including Level-1B/HDF data production system)

VAS Spectral Bands

	VIIRS #	Centerλ(nm)	$\Delta\lambda$(nm)	SNR/NEΔT*
1.	M1	412	20	880
2.	M2	445	18	840
3.	M3	488	20	800
4.	M4	555	20	750
5.	M5	672	20	900
6.	M6	746	15	580
7.	M7	865	39	500
8.	M8	1.240μm	20	75
9.	M9	1.378	15	150
10.	M10	1.610	60	275
11.	*MAS15*	*1.880*	*50*	--
12.	M11	2.250	50	110
13.	M12	3.700	180	0.05 NEΔT
14.	M13	4.050	155	0.07
15.	*MOD27*	*6.715*	*360*	*0.25*
16.	M14	8.550	300	0.05
17.	M15	10.763	1000	0.05
18.	M16	12.013	950	0.05
19.	*MOD33*	*13.3*		*0.25*

20. ***** Based on the equivalent VIIRS orbital pixel size

Phased Development Approach

Phase 1: Implement VIIRS Bands on the NASA MAS System

Design and build a VIIRS-like Spectrometer, compatible with the exisiting MAS Opto-Mechanical Module (OMM) and data system and begin collecting data.

Phase 2: Build a dedicated VIIRS Airborne Simulator Instrument (based on an improved MAS design)

Design and build:

-- Dedicated Opto-Mechanical Module (with new-design blackbodies)

-- New data system (MAS follow-on design)

Phase 3: Advanced technology system

-- Design and build next-generation airborne line-scanner

-- Re-use high-value elements (e.g. filters, detector arrays)

-- Long-term solution for VIIRS airborne simulation

-- UAV-Compatible

Estimated Development Timeline

- Phase 1 – VAS Spectrometer 16 Months
- Phase 2 – Data System, OMM & Calibrators 18 Months
- Phase 3 – Advanced System TBD
- All phases could be conducted in parallel. (Seed-money for preliminary design work could accelerate schedules.)