CERES Cloud Working Group Report

CERES Science Team Mtg., Virtual#5, 26-28 April 2022

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P. Yang (ice models), Texas A& M University

Thanks to Dave Doelling and his TISA/calibration teams!

Topics

- Data processing status
- Ed5 algorithm development update
  - LEO and GEO algorithm plans and status
  - Update on clear sky radiances, atmos. correction
  - Algorithm revision for 2-channel GEOsats
- Documentation update

Clouds Processing Status (MODIS & VIIRS)

CERES-MODIS Edition 4 (*CDR)	*Aqua: Jul 2002 – Jan 2022 (~ 19.5 y)* *Terra: Feb 2000 – Jan 2022 (~ 22 y)*	• ***Uses frozen Ed4 cloud codes delivered in 2013*** • ***MODIS Collection 5 radiances thru Feb 2016,*** • ***MODIS Collection 6.1 March 2016 – present and scaled to C5 for consistency over entire record*** • ***Terra-MODIS normalized to Aqua-MODIS (Sun-Mack, et al. 2018)***
CERES-VIIRS Edition 1A	*SNPP: Jan 2012 – Jul 2021 (~ 9.5 y)* *NOAA-20: Jan 2018 – Jul 2021 (~ 3.5 y)*	• ***Uses VIIRS Ed1A cloud code*** • ***SNPP uses forward processing calibrations (C1 radiances), not scaled to MODIS; has discontinuity ~2016 due to a calibration update by SIPS*** • ***N20 uses C2 radiances and scaled to MODIS C5***
CERES-VIIRS Edition 2A	*SNPP: Jan 2012 – Jan 2022 (~ 10 y)*	• ***Uses VIIRS Ed1A cloud code*** • ***Uses C2 radiances and scaled to MODIS C5***
CERES-VIIRS Edition 1B (*CDR)	*NOAA-20: Jan 2018 – Jan 2022 (~ 4 y)*	• ***Uses new version of VIIRS cloud code (temporary continuity version until Ed5 is released)*** • ***Fills Aqua-MODIS gap in Aug 2020***

Ed5 Cloud Algorithm Development Plans

Major objective is to improve cross-platform consistency of cloud properties between MODIS, VIIRS and across more than 20 GEO satellites

- The CERES CDR will be extended with NOAA-20 data products which requires cloud properties from VIIRS and MODIS that are as consistent as possible to avoid discontinuities/artificial trends.

- In Ed5, we plan to apply consistent algorithms to MODIS and VIIRS that uses common channels and employs a combination of theoretical and empirical approaches to account for sensor differences (e.g. spectral response functions and resolution).

- CERES record also comprised of 20+ GEO satellites with wide range of available spectral information. In Ed4, we applied satellite specific algorithms to capture as much spectral info as possible which led to large discontinuities over some regions.

- For the GEO's, a consistent approach that uses channels common on most satellites (0.63, 3.9, 11, 6.7 µm) is being explored.

- Ed5 will also have many bug fixes, updated cloud models, and many improvements to reduce uncertainties, particularly in polar regions, at night, and within the solar terminator

Ed5 Cloud Algorithm Development Status

Ed5 LEO (MODIS and VIIRS)

- Ed5 processing framework for MODIS and VIIRS is completed.
- AQUA-MODIS radiance ingester modified to resurrect 1.6 um band (was not used in Ed4).
- Many bug fixes, algorithm and ancillary dataset improvements are already implemented including improved polar clou properties utilizing the 1.6 µm band. Others in progress: polar night cloud detection, nighttime tau, day/night heights and phase.

Ed5 GEO

- A common 3-channel algorithm is implemented in the CERES GEO processing framework for most satellites.
  - daytime: 0.63, 3.7, 11 µm (cloud mask, standard cloud properties incl theoretical tau, R_e)
  - nighttime: 3.7, 6.7, 11 µm (cloud mask, theoretical tau for thin clouds coupled with machine learning for Re and thick cloud optical depth)
- A different algorithm is being developed for the 2-channel satellite (GMS-5, Met-5 and Met-7)
- Exploring machine learning approaches to reduce artifacts near sunrise/sunset.

Ed5 Cloud Algorithm Development
Clear Sky Radiances

- The various LEO and GEO cloud retrieval algorithms require estimate clear sky (cloud free and background cloud removed) radiances that depend on surface properties, temperature and humidity profiles.

- Atmospheric reanalyses are relied on for some of this information (e.g. GEOS 5.4.1 Tskin, T(z), q(z) are used in Ed4) but the system to be employed in Ed5 has not yet been determined.

- In addition, poor accuracies associated with other ancillary data products and methods also limit the ability to derive consistent cloud properties across dozens of platforms with different spectral capabilities, particularly spectrally dependent surface reflectances, emissivities and atmospheric absorption which all must be accounted for based on the spectral response functions of the different satellite sensors.

- We've made good progress to improve clear sky radiances for Ed5 (i.e. land and ocean surface reflectances, emissivities, and atmospheric corrections) and to mitigate uncertainties associated with skin temperatures from reanalyses.

Atmospheric Correction for Ed5

Continue to employ correlated k-distribution method

- Increased number of levels from 19 to 58
- Accounting for satellite specific SRF’s across all platforms
- Improved segmentation across spectral bands for various gases
- Continuum absorption updates for 3.8 μm band
- Improved 3.8 μm ocean solar reflectance model

CERES GEO Atmospheric Correction Update

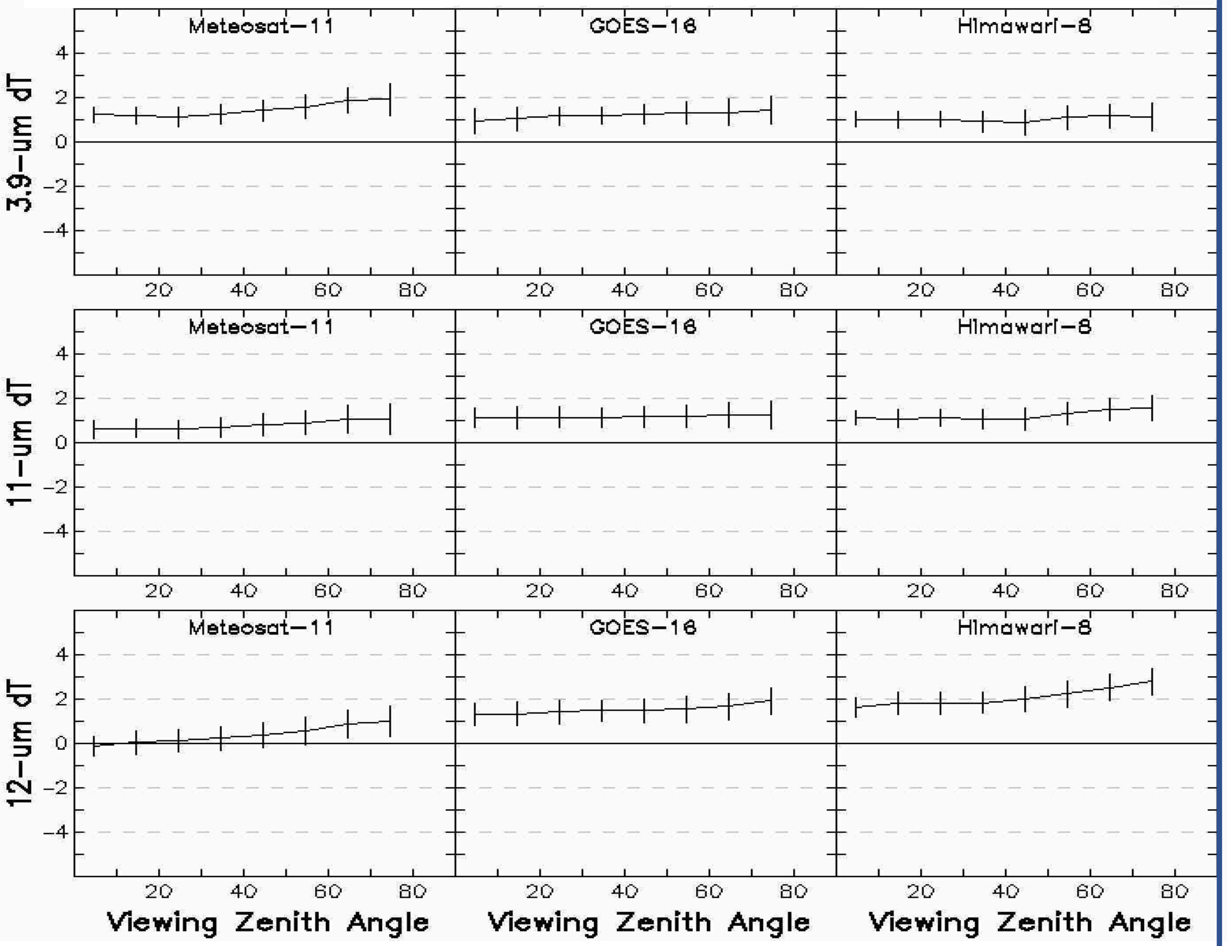
NIGHTTIME evaluations over Clear-sky Ocean

(Calculated minus Observed BT's)

G. Hong, F.L. Chang

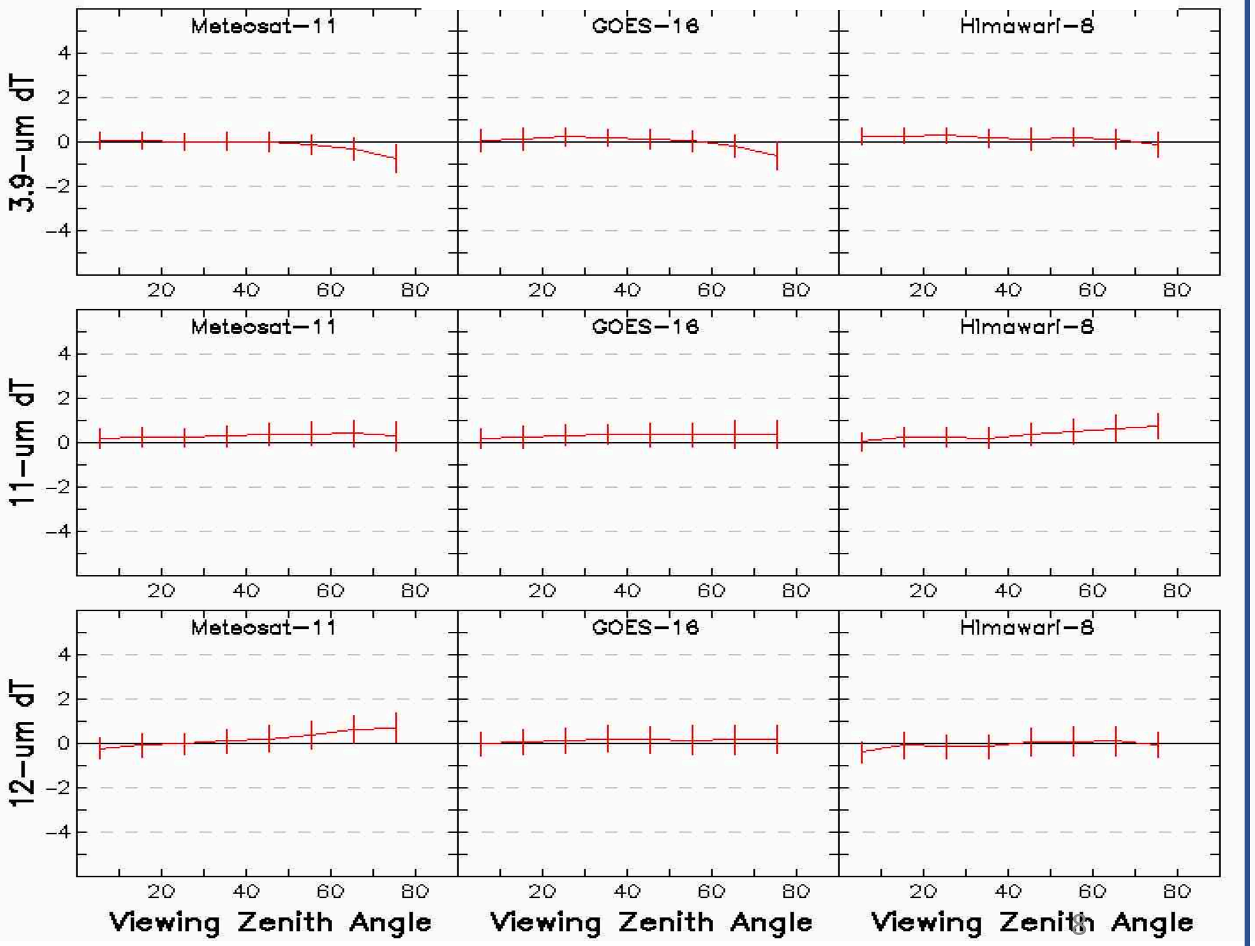
Ed4 GEO Errors > 1K

Meteosat-11 GOES-16 Himawari-8



Updated for Ed5 Errors < ~ 0.2 K

Meteosat-11 GOES-16 Himawari-8



CERES GEO Atmospheric Correction Update

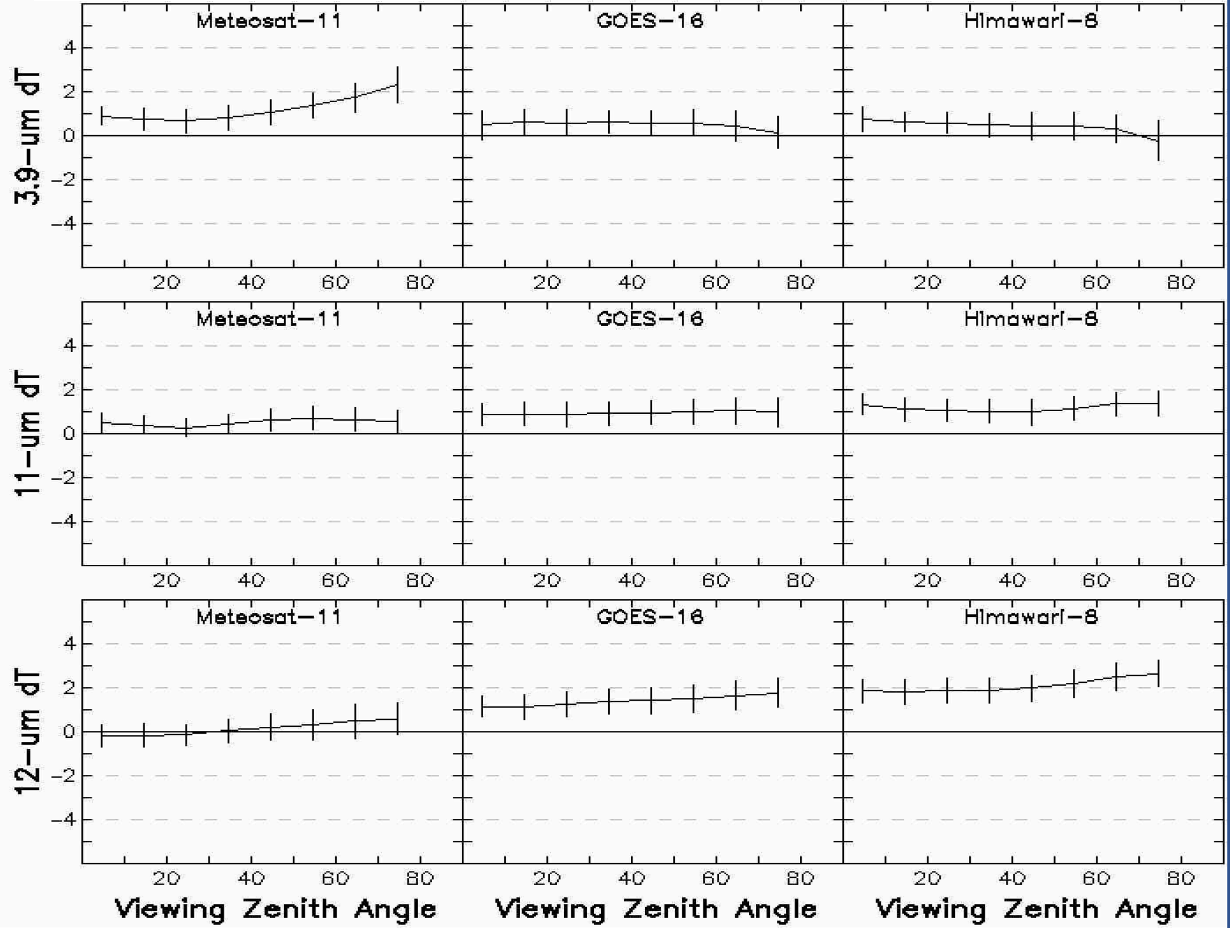
DAYTIME evaluations over Clear-sky Ocean

(Calculated minus Observed BT's)

G. Hong, F.L. Chang

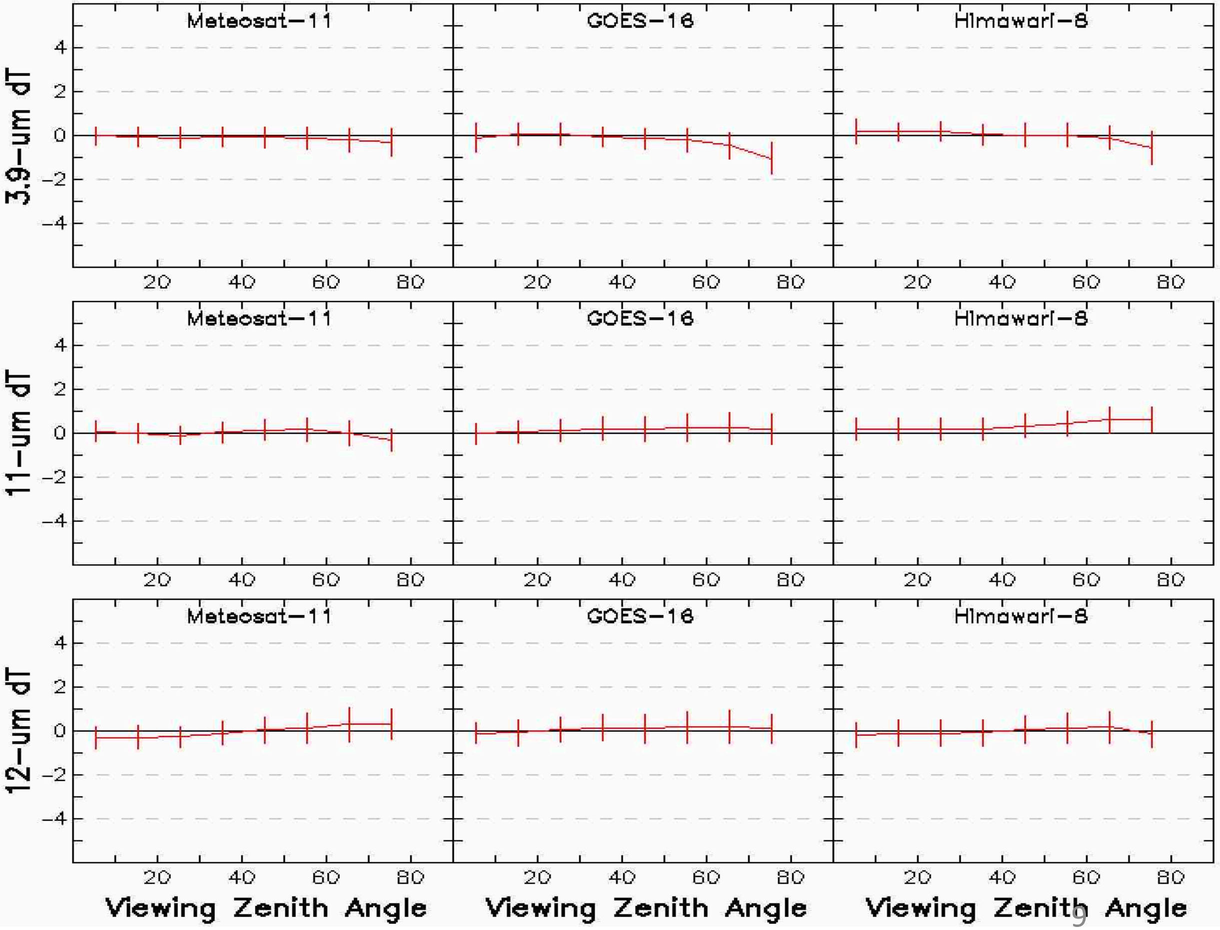
Ed4 GEO Errors > 1K

Meteosat-11 GOES-16 Himawari-8



Updated for Ed5 Errors < ~ 0.2 K

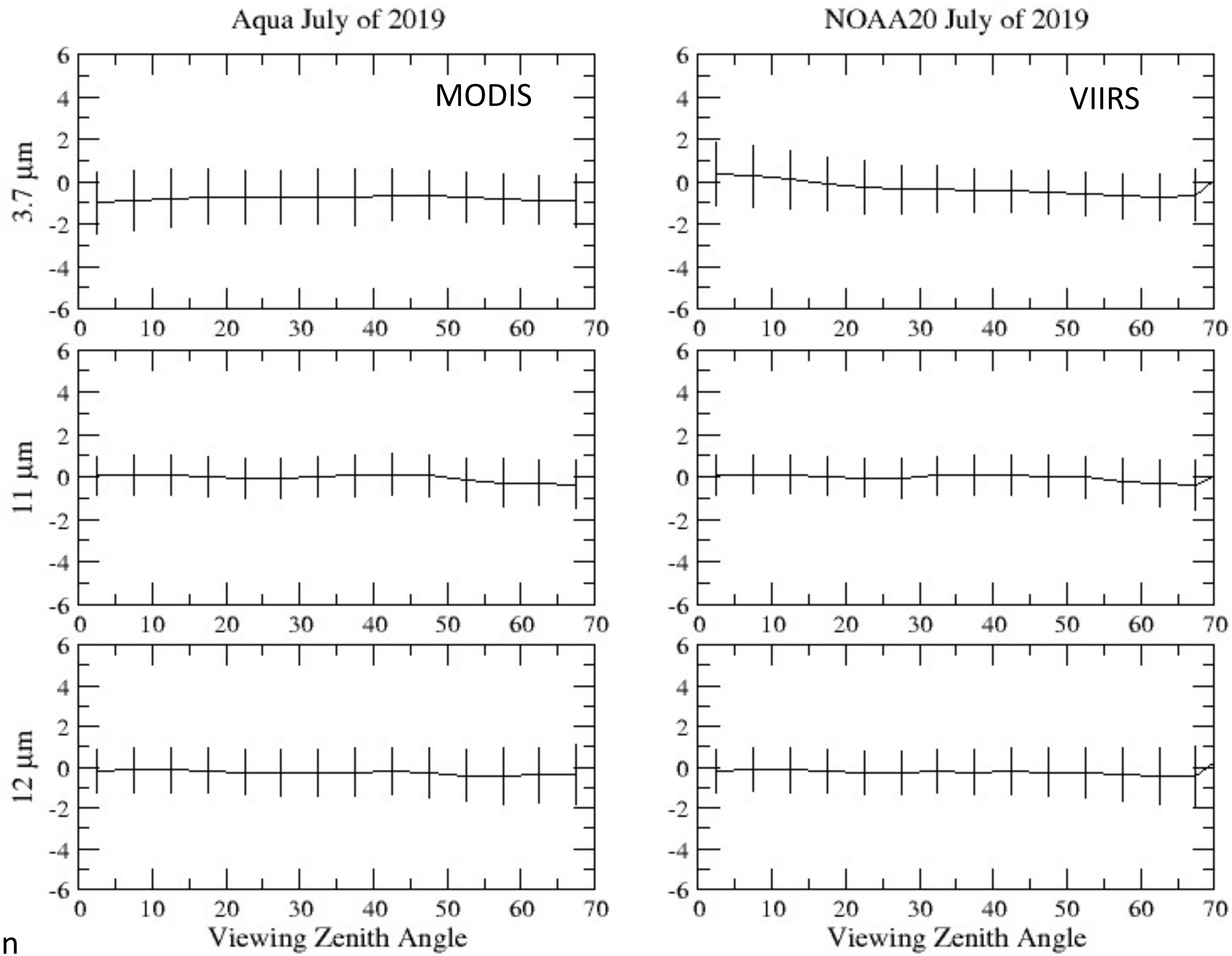
Meteosat-11 GOES-16 Himawari-8



MODIS/VIIRS Atmospheric Correction Update

- MODIS and VIIIRS very consistent
- 3.7 µm needs more work

DAYTIME: Calculated minus Observed BT’s

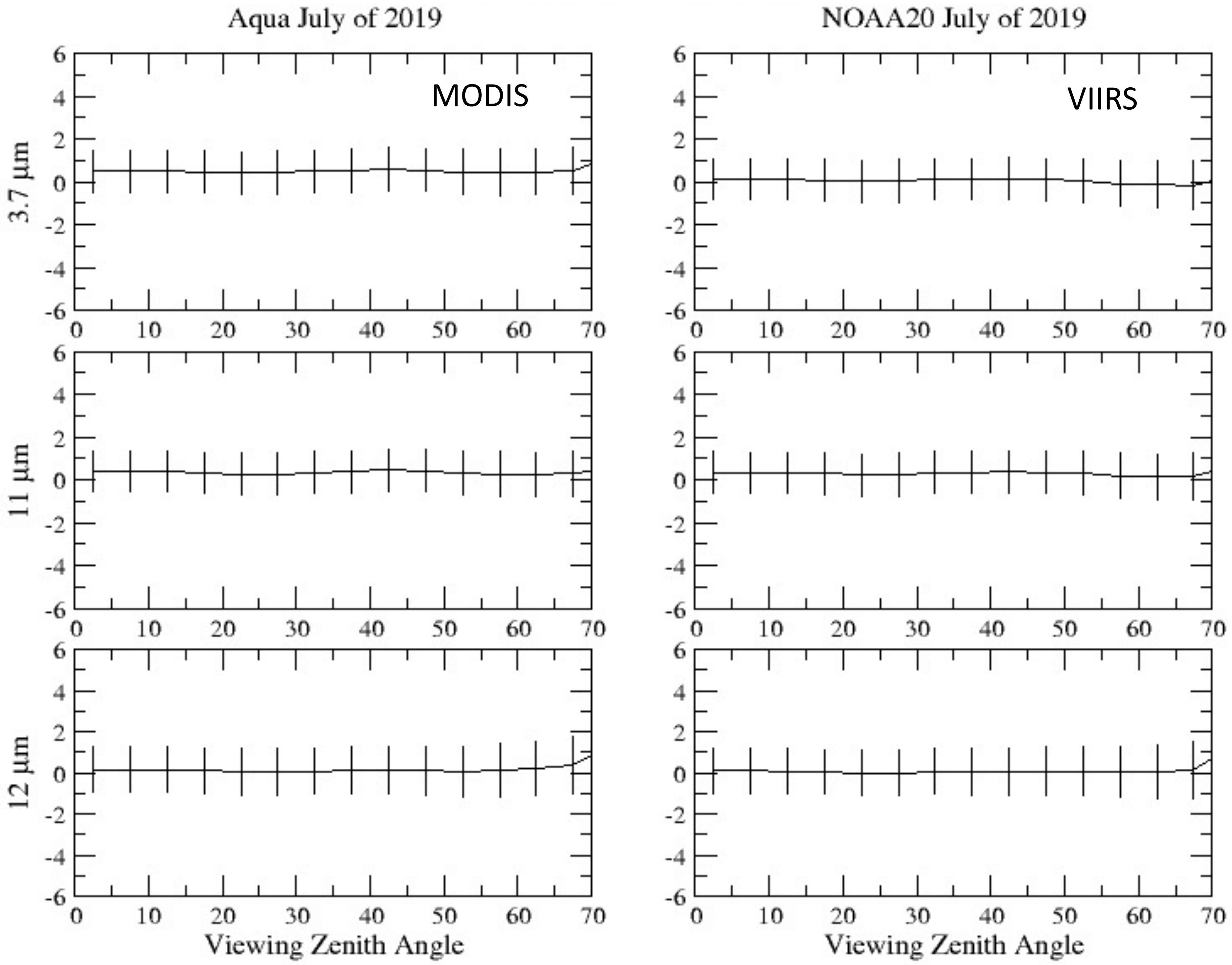


Courtesy of S. Sun-Mack and Y. Chen

MODIS/VIIRS Atmospheric Correction Update

- MODIS and VIIRS very consistent
- 3.7 μm needs more work
- More cloud contamination at night?

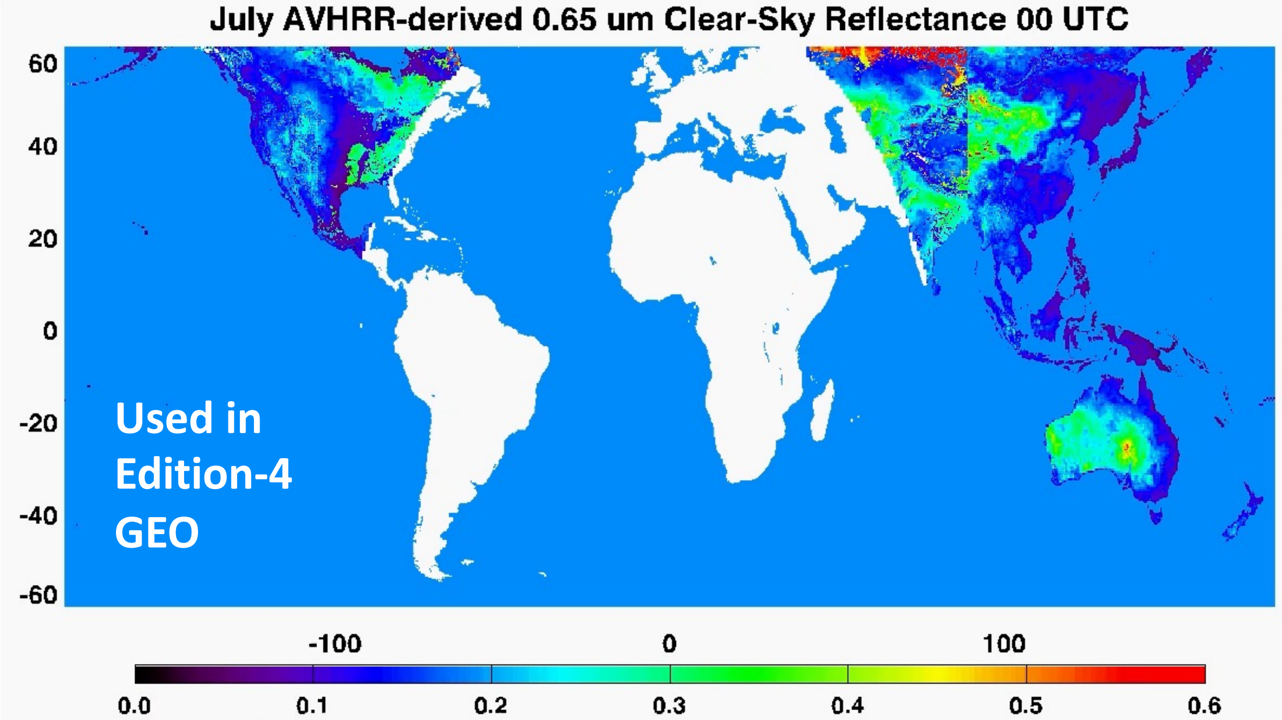
NIGHTTIME: Calculated minus Observed BT's

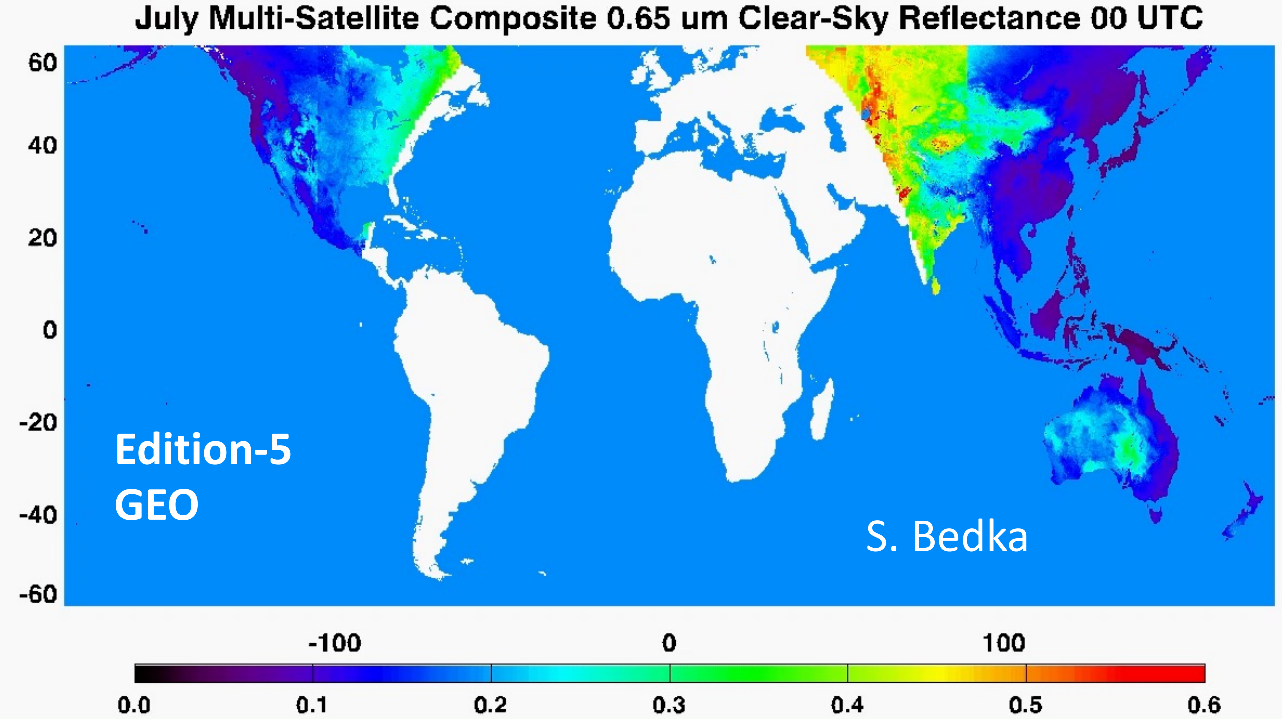


Surface Reflectances

- In CERES MODIS and VIIRS forward processing, dynamic clear sky reflectance maps are employed over land with daily updating based on clear pixels discerned by the cloud mask.
- In CERES GEO processing, there is no updating scheme.
- Over oceans we use the wind speed dependent reflectance model by Jin et al, (2006)

New clear-sky reflectance maps for Ed5 GEO (~0.63 µm)





Edition-4 GEO

- Static monthly overhead albedo maps from an AVHRR climatology
- Directional models (from MODIS) and bidirectional models (from ERBE and aircraft data) used to convert to bi-directional reflectance
- Led to large errors for some angles and surface types

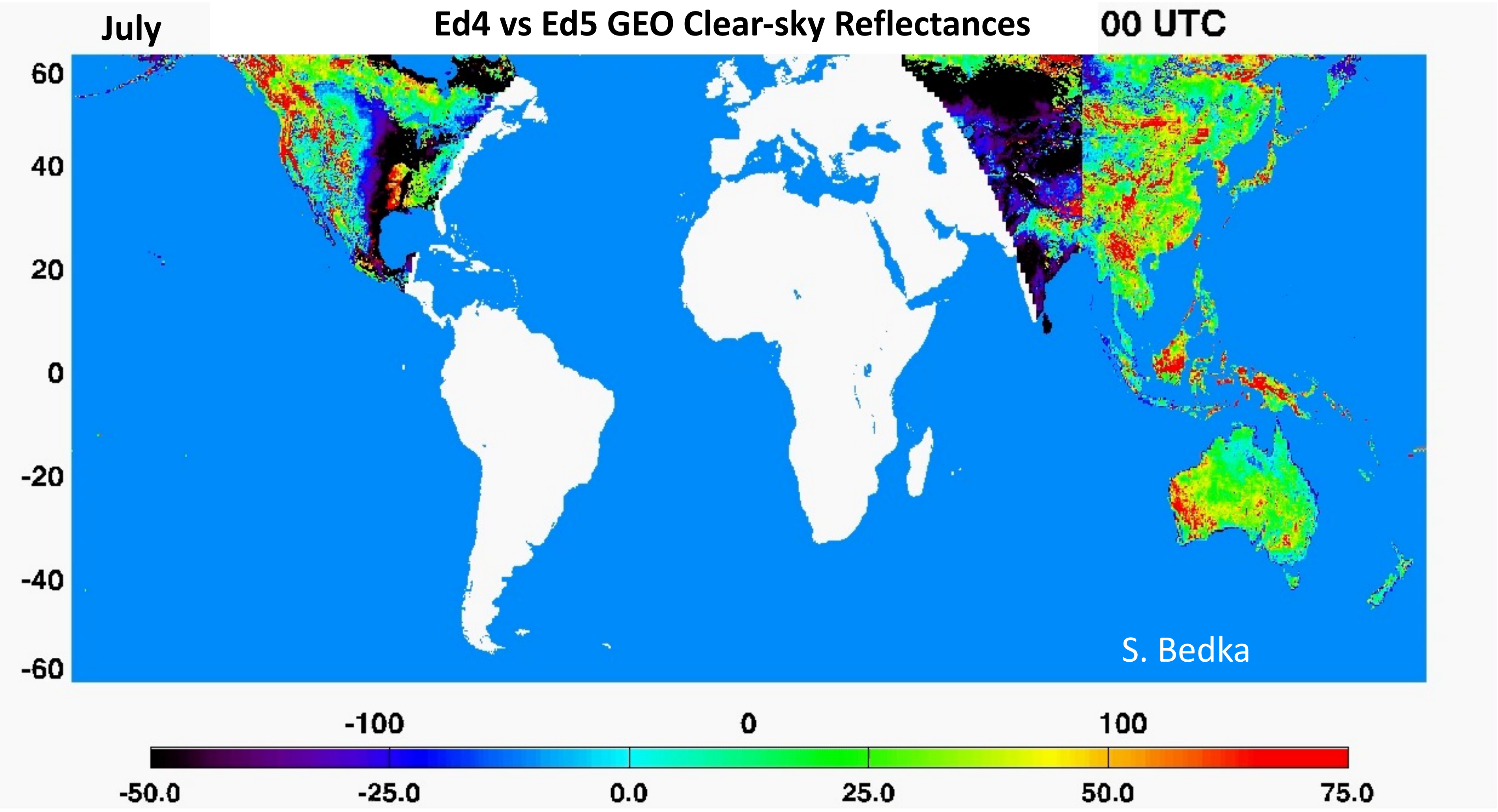
Edition-5 GEO

- Monthly, hourly reflectances composited from 2-years of global GEO data

Significantly reduces the impact of uncertainties in the directional and bi-directional models

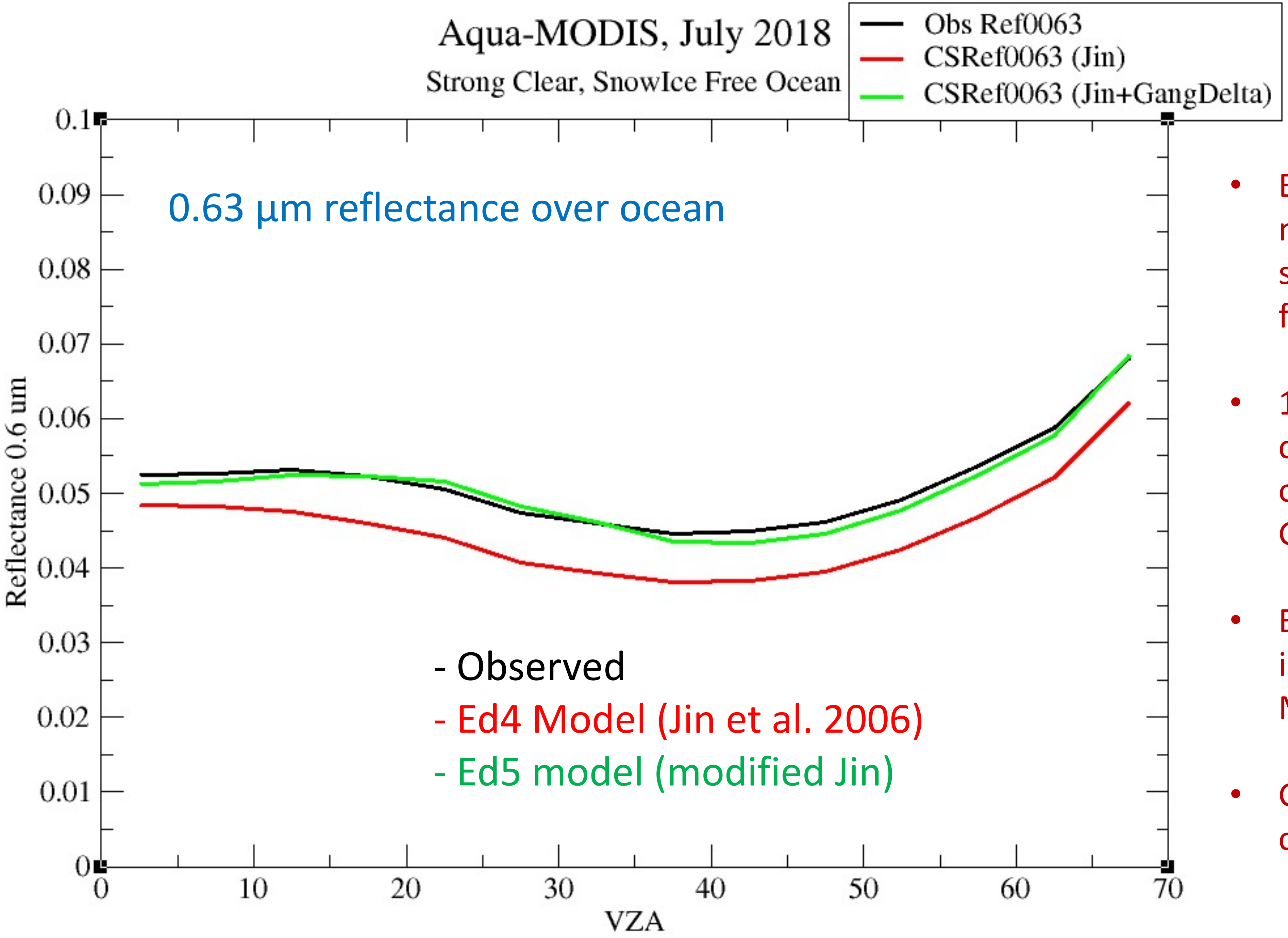
Hourly Clear-Sky Reflectance Comparison

Percent Difference



Hourly reflectance maps expected to lead to more accurate and consistent GEO cloud properties for Ed5

Implementation and testing in progress



- Ed4 ocean reflectance model accounts for surface roughness and fixed AOT = 0.1
- 15-20% too dark compared to observations (LEO and GEO)
- Empirical adjustment improves agreement with MODIS observations
- GEO evaluations and corrections in progress

Courtesy of G. Hong

Land Surface Emissivity and Skin Temperature

The CERES cloud mask is a thresholding approach that requires knowledge of the expected spectral clear sky temperatures that would occur in the absence of clouds.

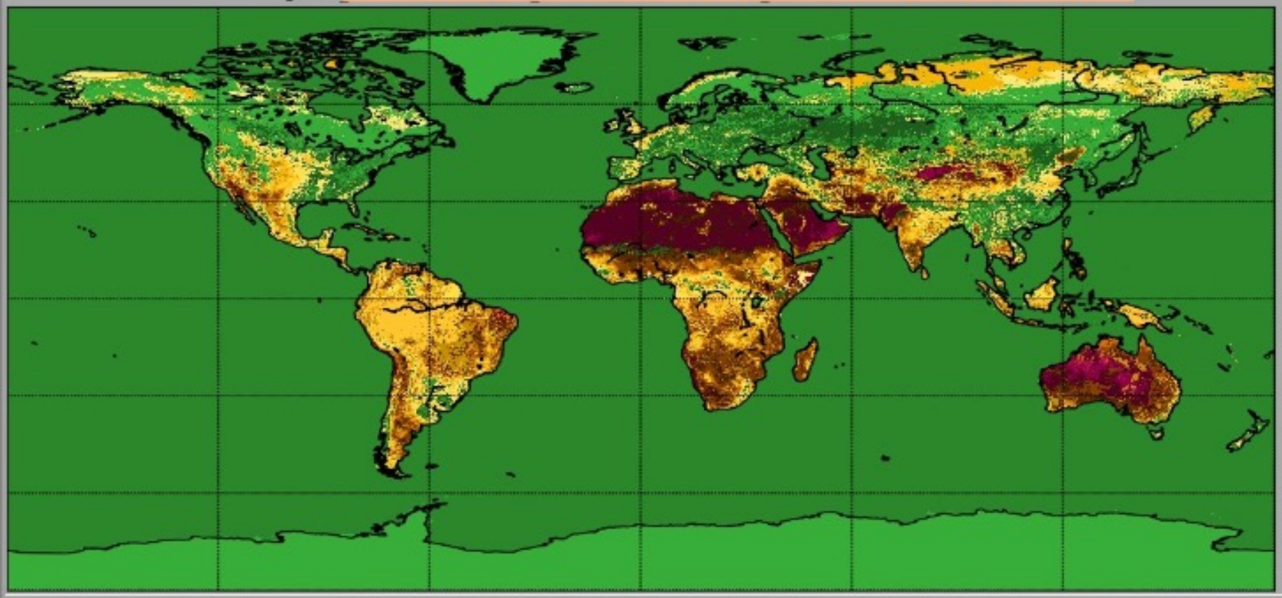
- A first guess is obtained by ingesting Tskin from a reanalysis system (GEOS 5.4.1 in Ed4), and accounting for the spectral surface emissivity and atmospheric absorption.
- Cloud mask is tuned visually and with CALIPSO to help account for clear sky temperature uncertainties (nighttime cloud mask much more sensitive to errors than daytime mask)

Cloud optical property and height algorithms require knowledge of the background emission temperature below clouds.

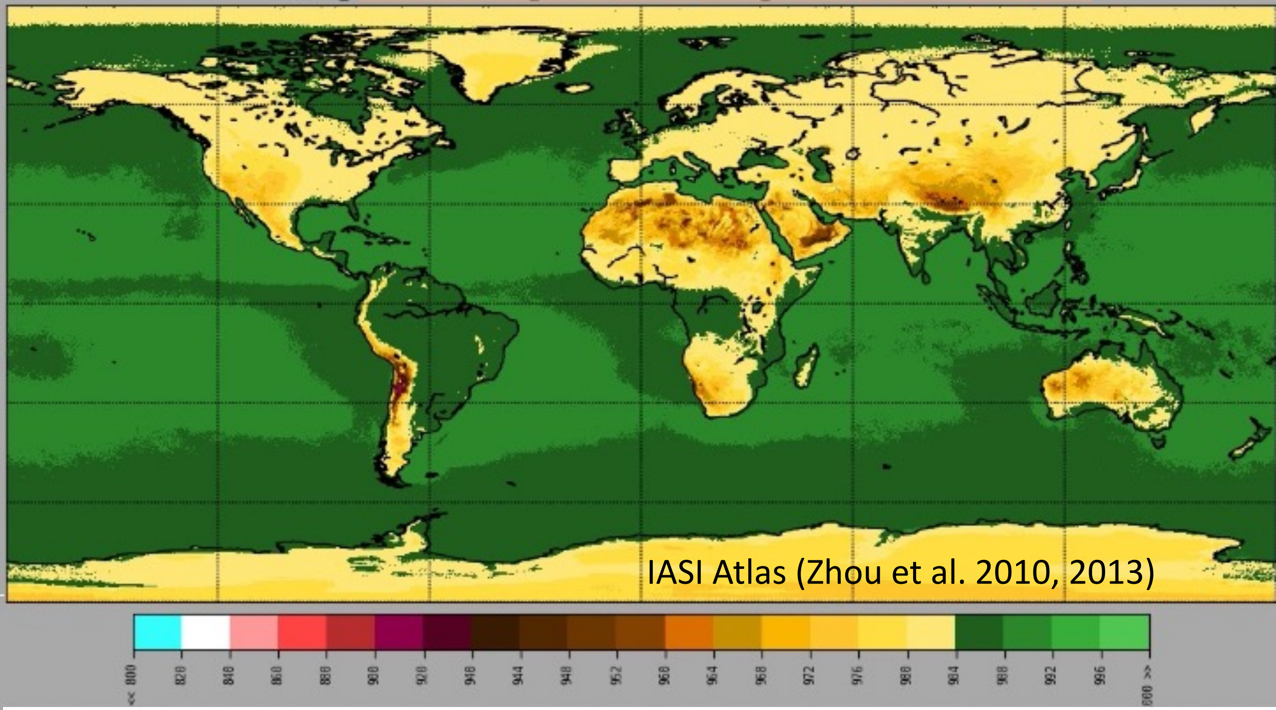
- Also computed using Tskin from reanalysis data. Tskin uncertainties are not mitigated in the cloud retrieval algorithms

Tskin is also derived from TOA 11 µm observations (clear areas determined from mask) and placed on the SSF. Accuracy depends on how well we specify the surface emissivity.

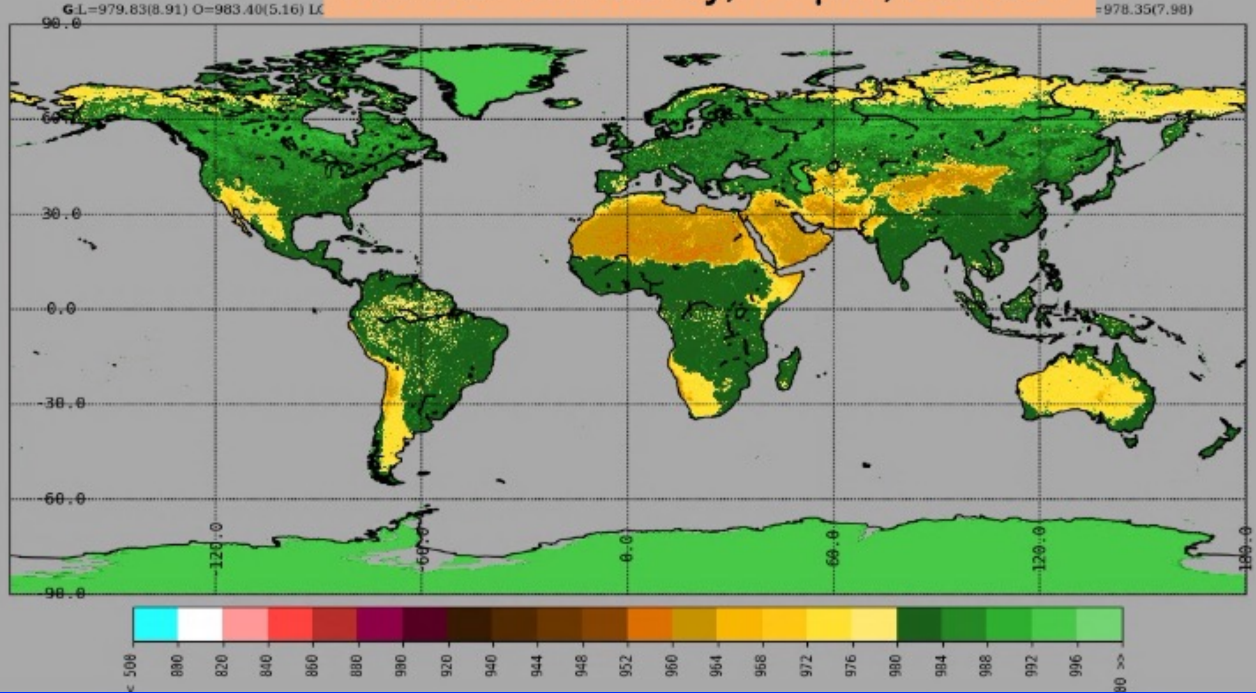
CERES Emissivity, 11 µm, January



Zhou Emissivity, 11 µm, January



MODIS Emissivity, 11 µm, 201801



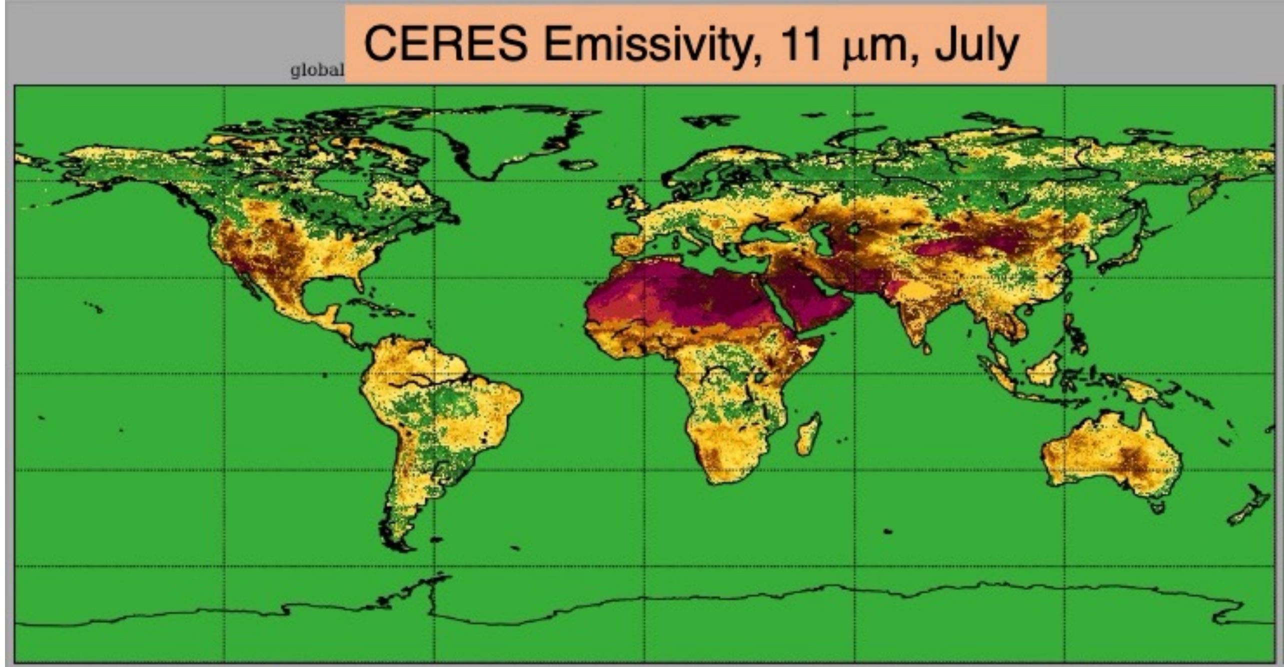
CERES-MODIS emissivity is derived from MODIS data by fusing daytime and nighttime 3.7 and 11 µm information. 3.7 solar reflectance term permits a solution but is not well known which increases the uncertainty

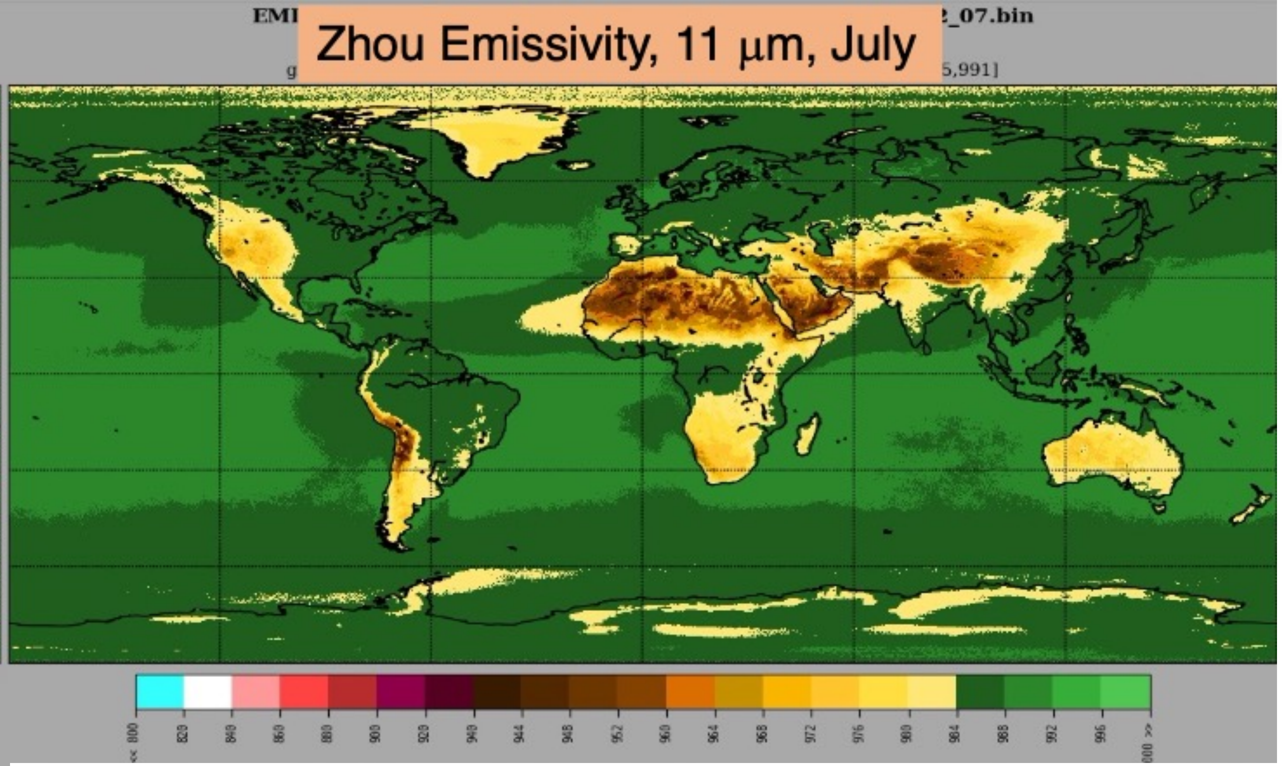
Over arid areas (i.e. Sahara, Australia)

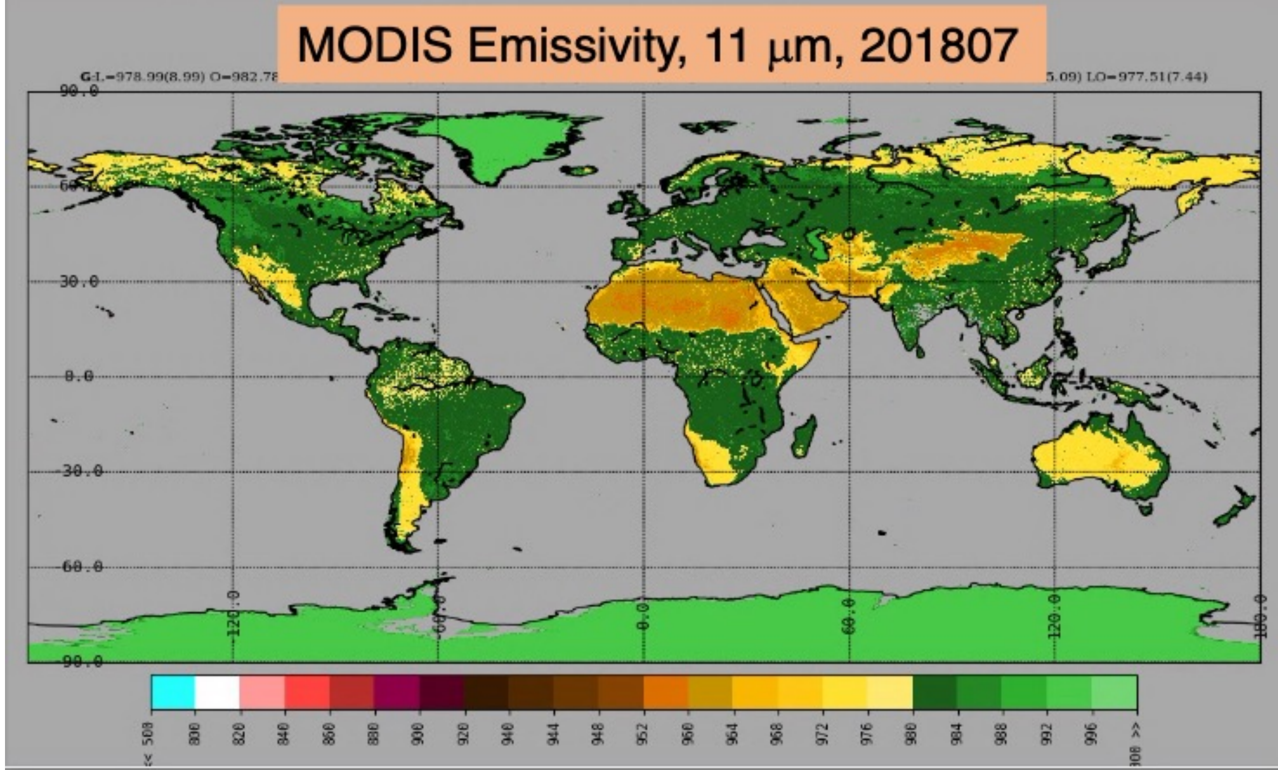
- CERES emissivity is the lowest
- MODIS and Zhou (IASI Atlas) agree well on average

Other areas

- Differences among methods are smaller but significant
- MODIS science team maps have no seasonal dependence, spatially smoother than Zhou/IASI and CERES







CERES emissivity derived from MODIS data by fusing daytime and nighttime 3.7 and 11 μm information. 3.7 solar reflectance term permits a solution but is not well known which increases the uncertainty

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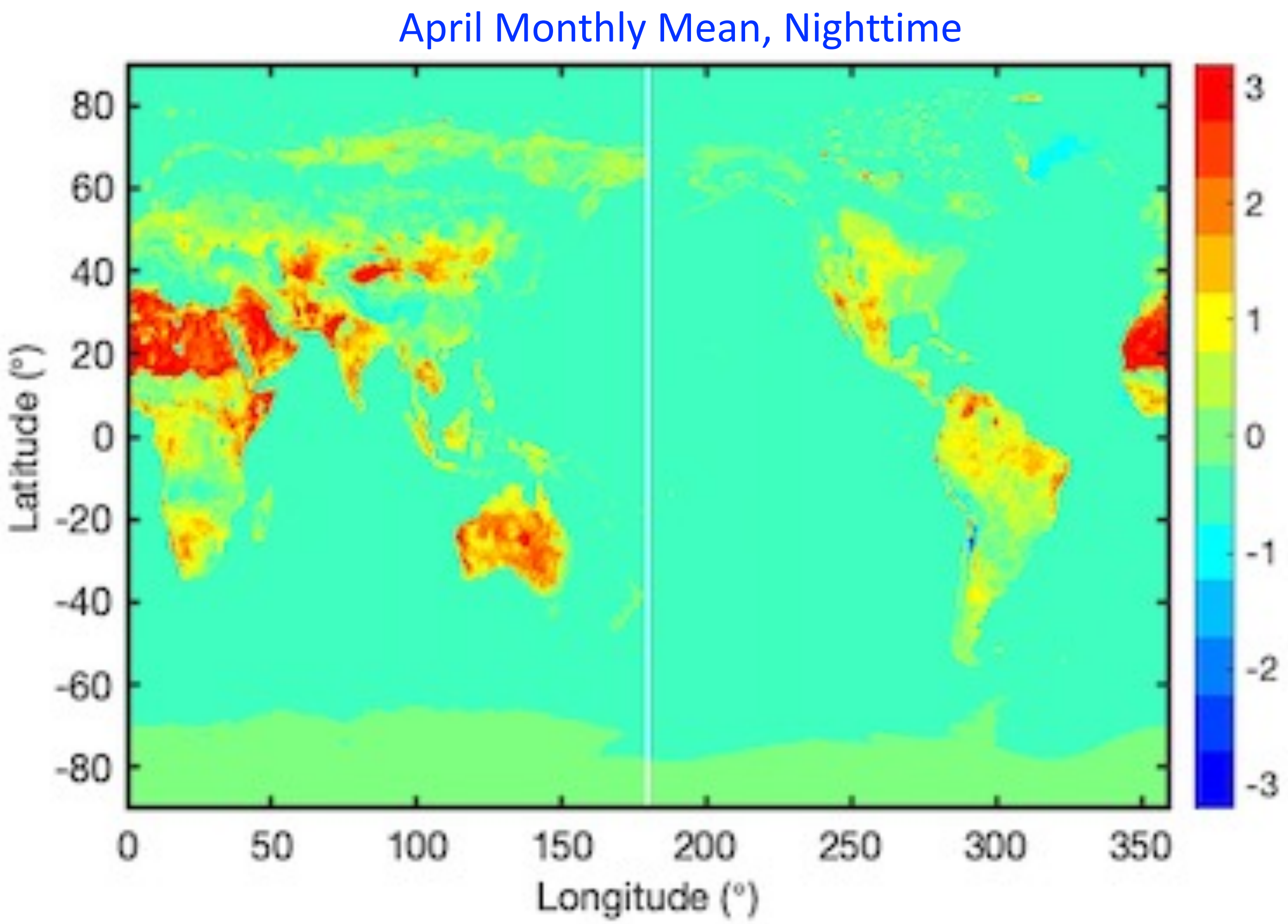
Satellite-derived Tskin Difference (CWG vs IASI Emissivity)

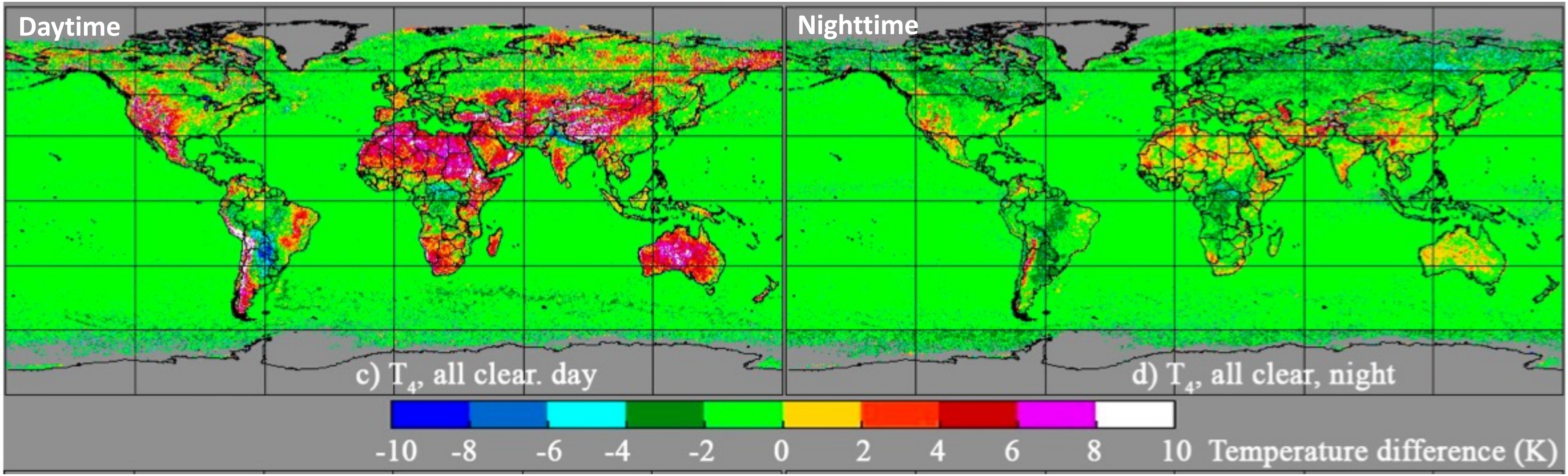


If Zhou is assumed to be accurate, then CWG Tskin is overestimated by up to 3K.

Significant regional differences found for computed and observed BT's over land in Ed4

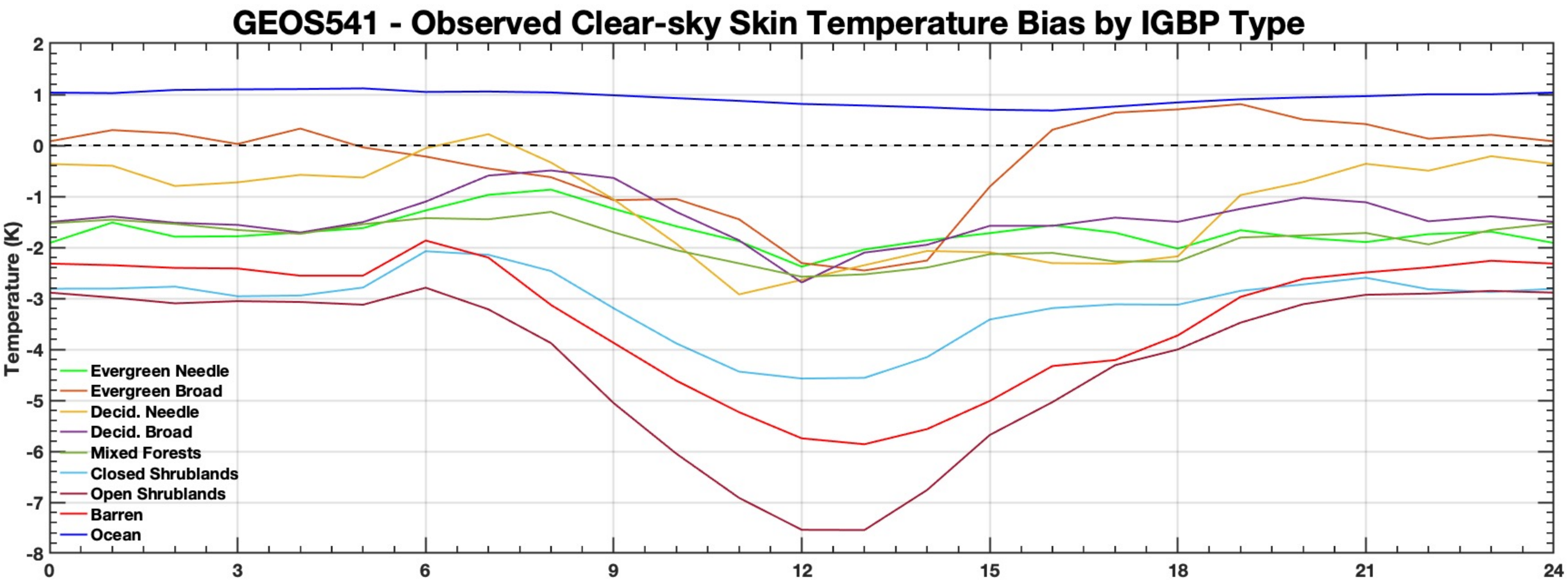
Clear-sky TOA 11um BT's (observations minus calculations)

4 seasonal months



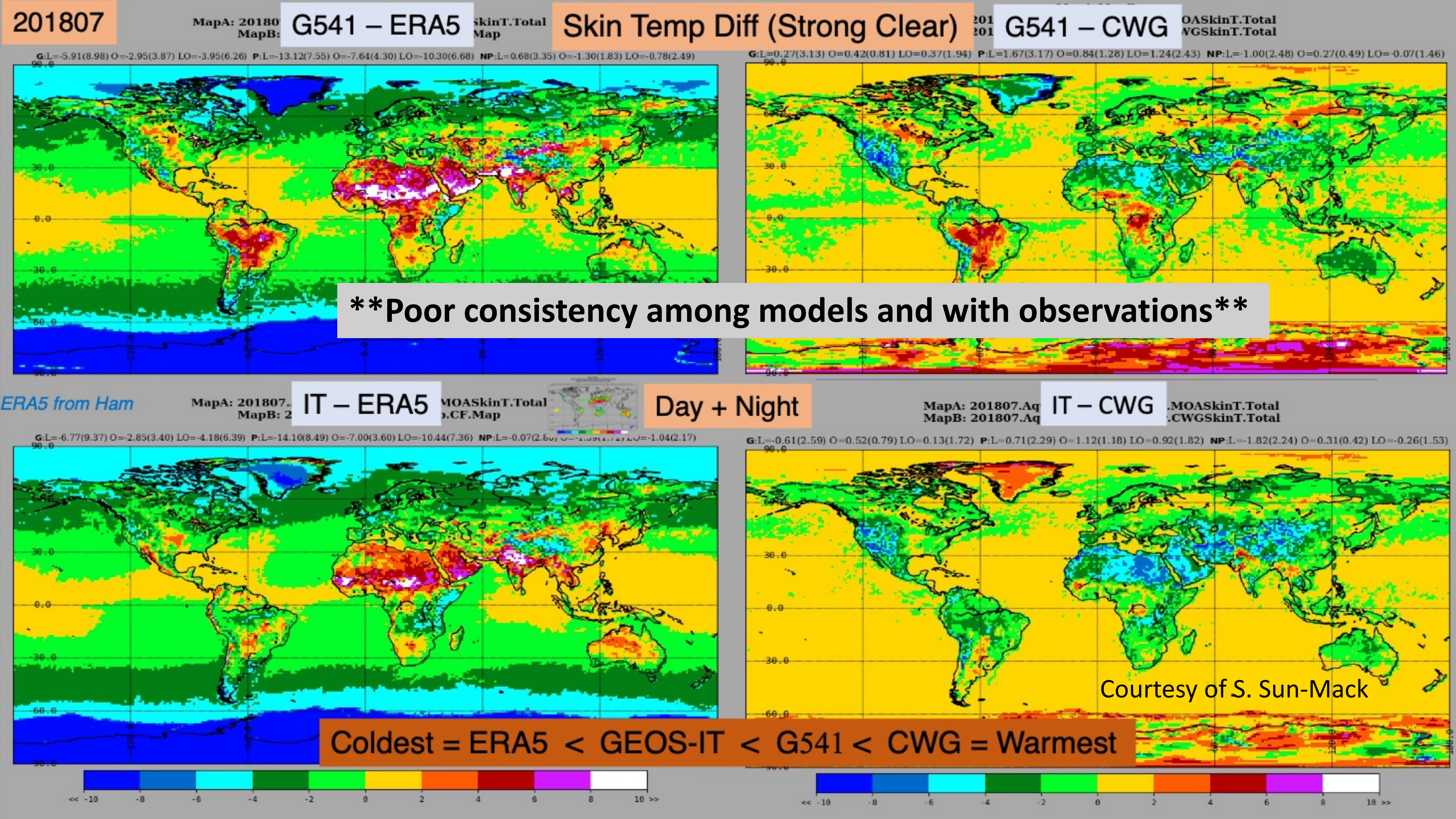
- CERES-MODIS emissivity errors contribute to the bias
- Satellite method is applied consistently at all times of day
- Large day/night difference is a problem with GEOS541 Tskin diurnal cycle

Skin Temperature Evaluations with Global (non-polar) GEO Data



B. Scarino

- Bias likely due to a combination of model and observation errors.
- Dependence on the time of day probably a problem with the model.
- Using the IASI emissivities would shift most of the curves up by various degrees


201807
Skin Temp Diff (Strong Clear)
G541 – ERA5
G:L=-5.91(8.98) O=-2.95(3.87) LO=-3.95(6.26) P:L=-13.12(7.55) O=-7.64(4.30) LO=-10.30(6.68) NP:L=0.68(3.35) O=-1.30(1.83) LO=-0.78(2.49)
G541 – CWG
G:L=0.27(3.13) O=0.42(0.81) LO=0.37(1.94) P:L=1.67(3.17) O=0.84(1.28) LO=1.24(2.43) NP:L=-1.00(2.48) O=0.27(0.49) LO=-0.07(1.46)
Poor consistency among models and with observations
ERA5 from Ham
IT – ERA5
Day + Night
G:L=-6.77(9.37) O=-2.85(3.40) LO=-4.18(6.39) P:L=-14.10(8.49) O=-7.00(3.60) LO=-10.44(7.36) NP:L=-0.07
LO=-1.04(2.17)
IT – CWG
MapA: 201807.Aq .MOASkinT.Total
MapB: 201807.Aq .CWGSkinT.Total
G:L=-0.61(2.59) O=0.52(0.79) LO=0.13(1.72) P:L=0.71(2.29) O=1.12(1.18) LO=0.92(1.82) NP:L=-1.82(2.24) O=0.31(0.42) LO=-0.26(1.53)
Courtesy of S. Sun-Mack
Coldest = ERA5 < GEOS-IT < G541 < CWG = Warmest
<< -10 -8 -6 -4 -2 0 2 4 6 8 10 >>

Plans for Edition-5 Development Systems

Skin Temperature and Clear Sky IR Radiances

- Switch to the emissivities from the IASI atlas(11 um)
  - Theoretically, IASI should be more accurate
  - Initial tests confirm this for 11 µm (3.7 µm needs evaluation)
  - Can easily construct spectral maps for all GEO and LEO IR channels (IASI hyperspectral)
- We will continue to use GEOS541 in the Ed5 development systems
- Implement a Neural Net to predict Tskin (as observed from satellites) from GEOS541 variables
  - Has regional, scene type and time of day dependence
  - This will provide more accurate and regionally consistent values at all times of day that are constrained with satellite observations of Tskin (improved with IASI emissivities)
  - Could reduce the pain of re-tuning and other surprises once Ed5 reanalysis system is selected
- Once the Ed5 reanalysis system is selected, we will evaluate the model Tskin, derive a new Tskin Neural Net and re-evaluate the Ed5 algorithms with and without the NNET data from the new reanalysis system

CERES GEO CLOUDS UPDATE

Updating Cloud Properties For GEOs With Two Channels

- Ed4 cloud properties derived from the 2-channel satellite (GMS-5, Met-5 & Met-7) are associated with the largest discontinuities in the GEO timeseries.
- The daytime (2-chan) and nighttime (1-chan) algorithms were applied to modern satellites (Met-8 and Met-11 over Indian Ocean & W. Europe domains) so that they could be assessed against our 8-channel (multi-chan baseline) algorithm applied to the same SEVIRI imager data.
- Adjustments were made to the 2-chan algorithms to improve the consistency of the derived cloud properties with those from the multi-chan algorithm

Updating Cloud Properties For GEOs With Two Channels

P. Heck, M. Nordeen, B. Shan, C. Yost

Ed4 2-chan Algorithm characteristics

- Cloud mask applies fixed thresholds to the VIS reflectance and IR window BT
- Cloud properties are derived at the pixel level in three height layers; low (0-2 km), mid (2-6 km), high (6+ km)
- A 10 µm water droplet model is used to derive daytime optical depth for low clouds. A Cirrostratus model is used for daytime ice clouds (mid and high)
- Cloud heights are derived from the IR BT at night and IR BT and emissivity during daytime

Algorithm changes

- The clear/cloud IR brightness temperature thresholds were adjusted for daytime and nighttime from 6 K to 5 K over land and from 3 K to 1 K over ocean
- Cloud phase was changed from ice to water for all mid-clouds (daytime)
- Empirical relationship applied for cloud phase at night (IR BT compared to multi-chan cloud phase)

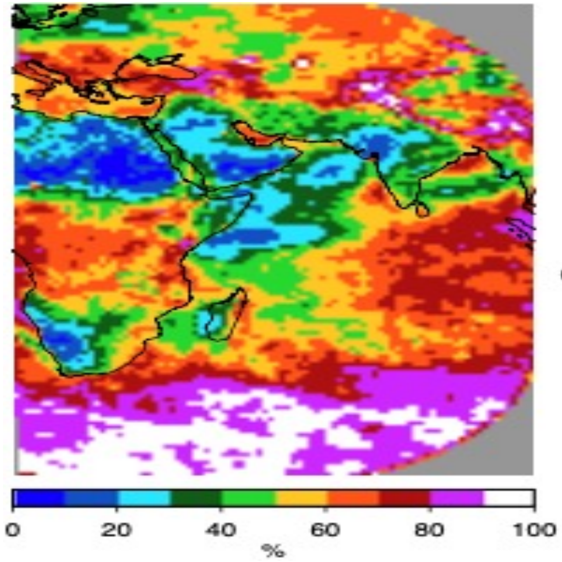
MET-8 Day
Total Cloud Fraction

Revisions

1 = Clear/Cloud IR Threshold Adjustments
2 = Revision 1 + mid clouds->water

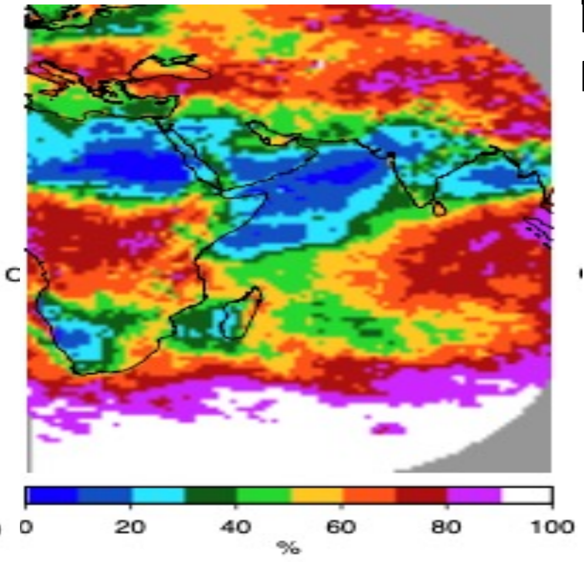
Ed 4 (2-chan)
Met-8 [April 2019]

Ocean	68.71
Land	49.40
Cld Frac	59.21

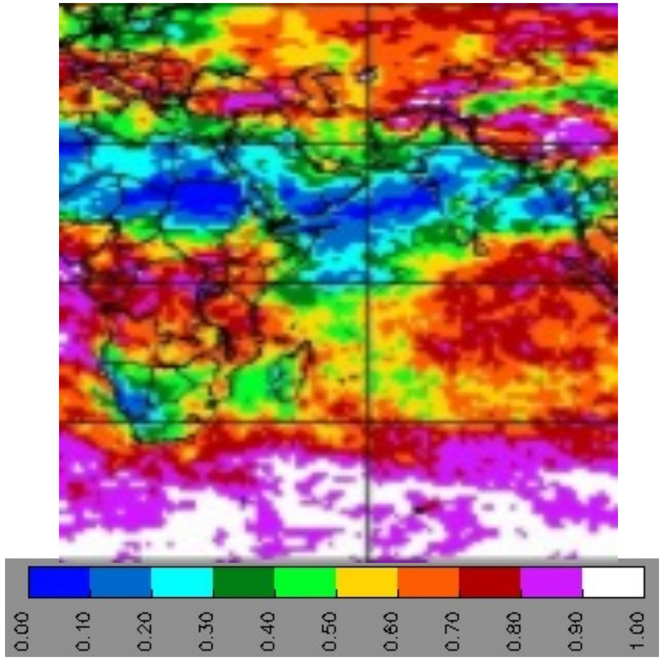


Ed4 Baseline (Multi-Chan)
Met-8 [April 2019]

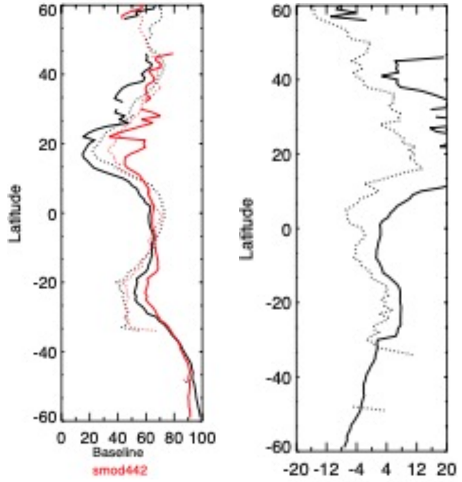
Ocean	66.40
Land	51.05
Cld Frac	58.85

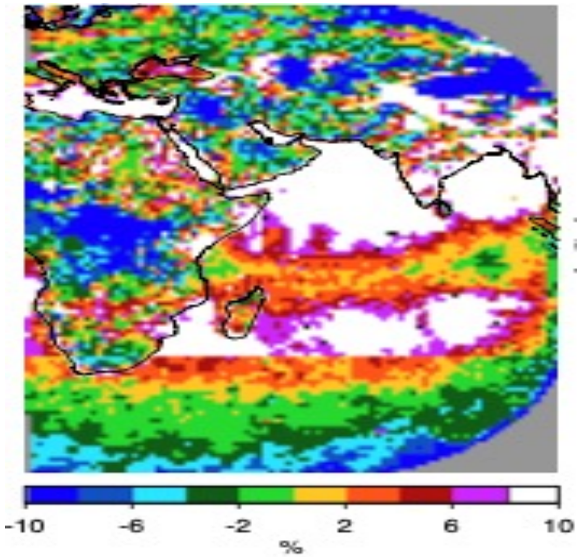


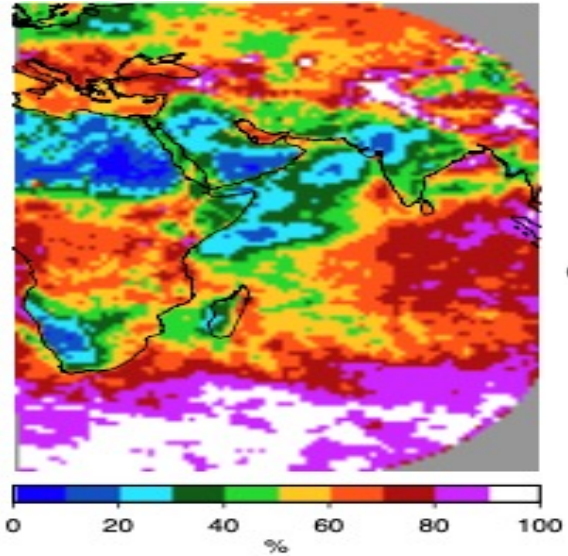
Aqua April 2019



Revision 2 - Baseline







Revision 2 (2-chan)
Met-8 [April 2019]

Ocean	70.62
Land	51.32
Cld Frac	61.12

MET-8 Day
Water Cloud Fraction

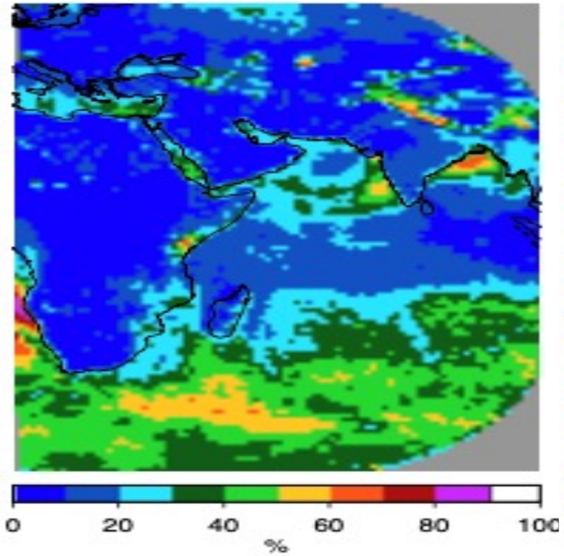
Revisions

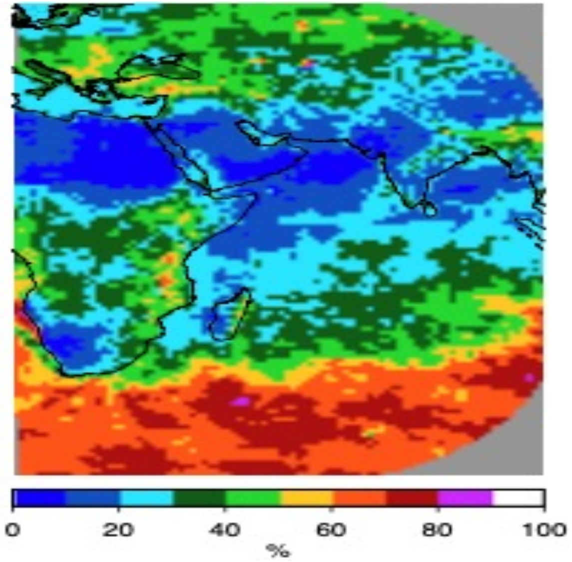
1 = Clear/Cloud IR Threshold Adjustments
2 = Revision 1 + mid clouds->water

Ed 4 (2-chan)

Met-8 [April 2019]

Ocean	32.30
Land	12.04
Cld Frac	22.33



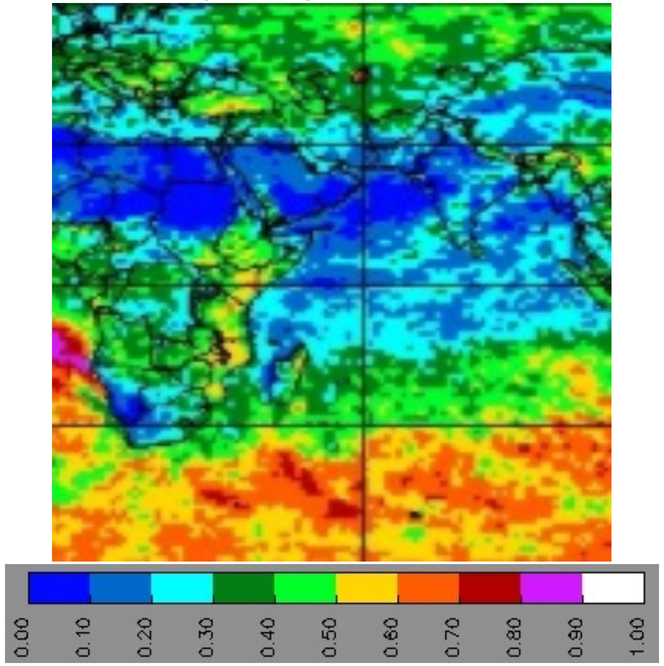


Ed4 Baseline (Multi-Chan)

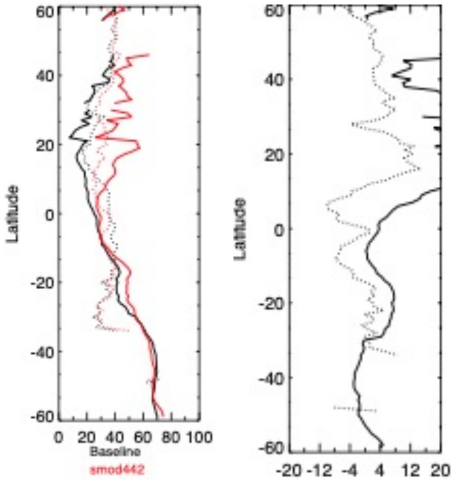
Met-8 [April 2019]

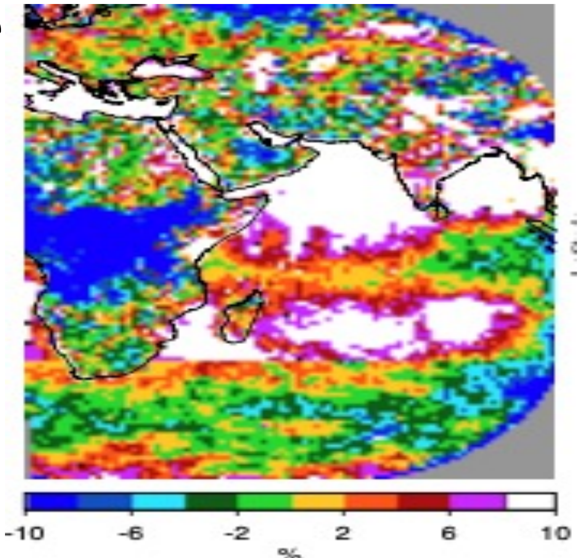
Ocean	45.86
Land	27.95
Cld Frac	37.05

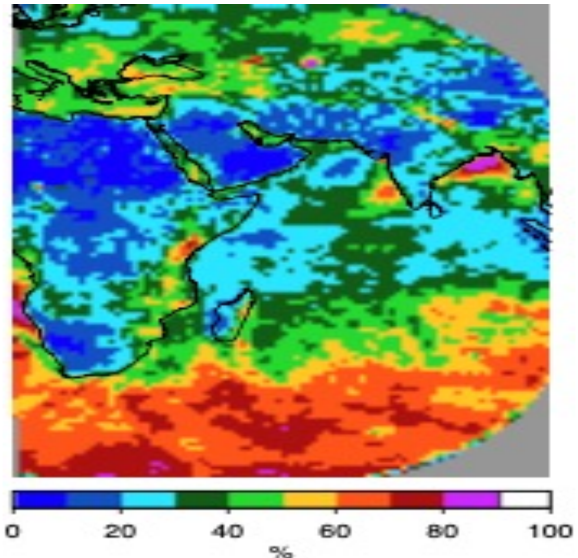
Aqua April 2019



Revision 2 - Baseline







Revision 2 (2-chan)

Met-8 [April 2019]

Ocean	50.21
Land	28.47
Cld Frac	39.52

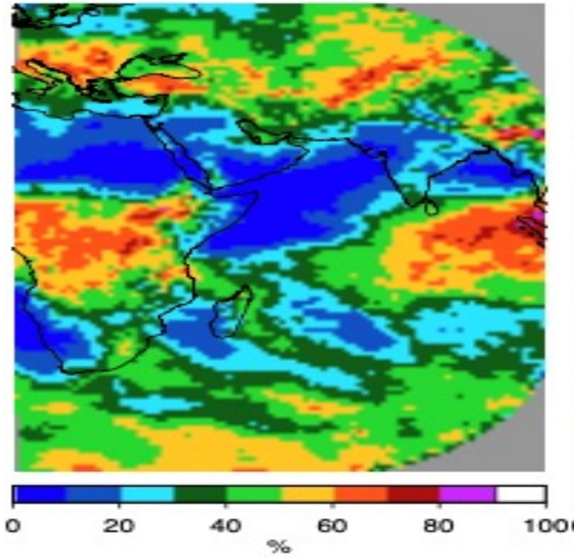
MET-8 Day
Ice Cloud Fraction

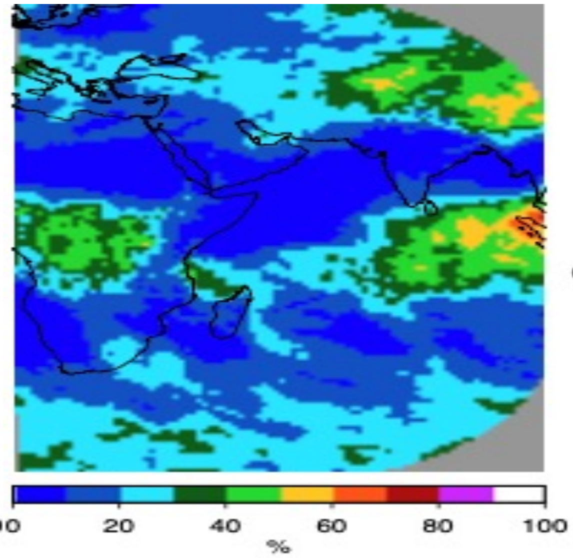
<u>Revisions</u>

1 = Clear/Cloud IR Threshold Adjustments
2 = Revision 1 + mid clouds->water

Ed 4 (2-chan)
Met-8 [April 2019]

Ocean	36.41
Land	37.36
Cld Frac	36.88

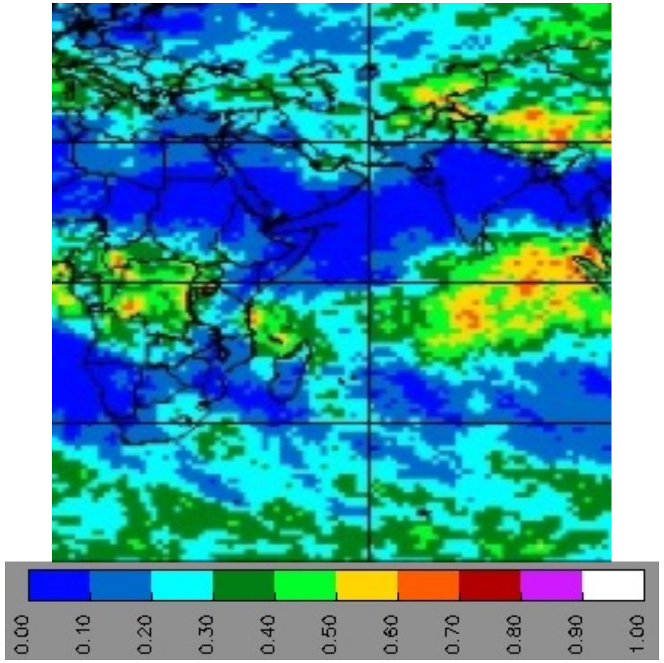




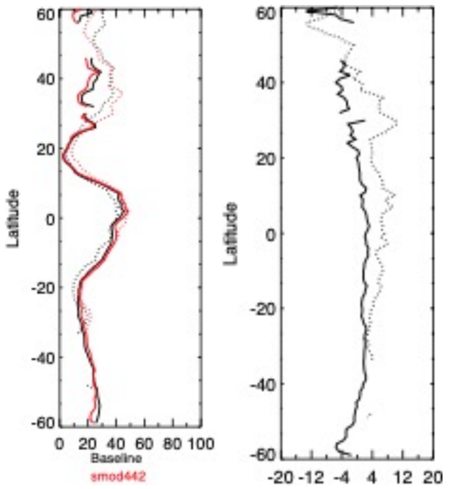
Ed4 Baseline (Multi-Chan)
Met-8 [April 2019]

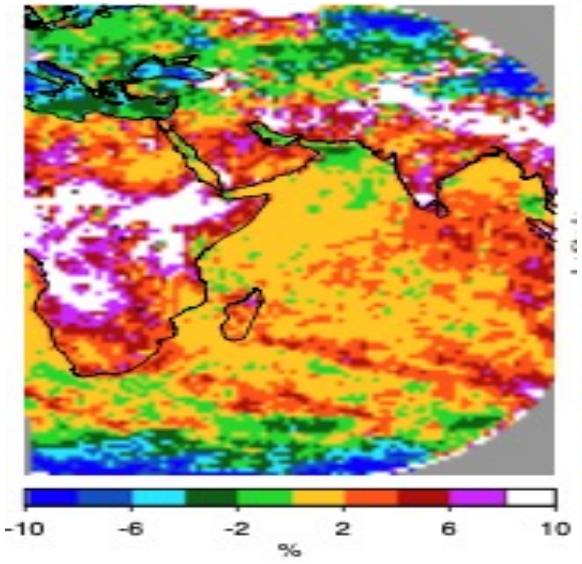
Ocean	19.83
Land	19.67
Cld Frac	19.75

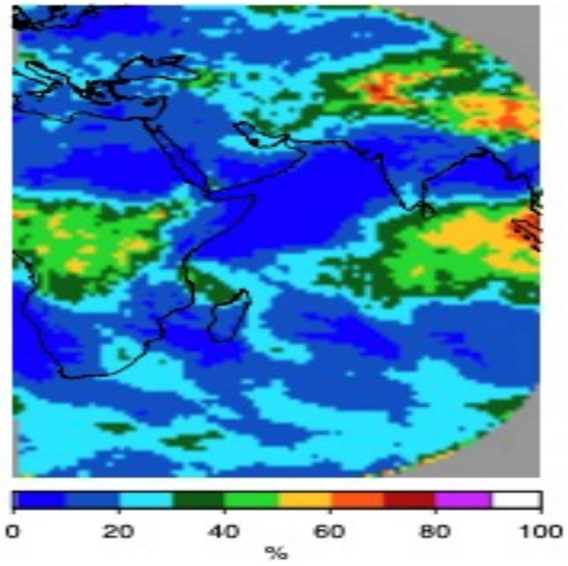
Aqua April 2019



Revision 2 - Baseline







Revision 2 (2-chan)
Met-8 [April 2019]

Ocean	20.40
Land	22.84
Cld Frac	21.60

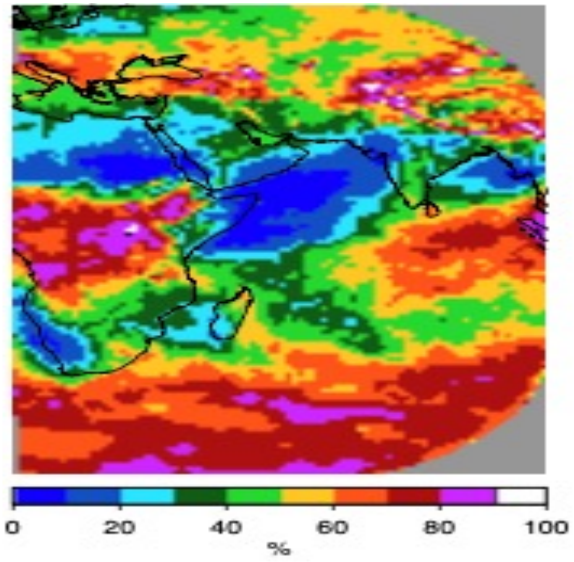
MET-8 Night
Total Cloud Fraction

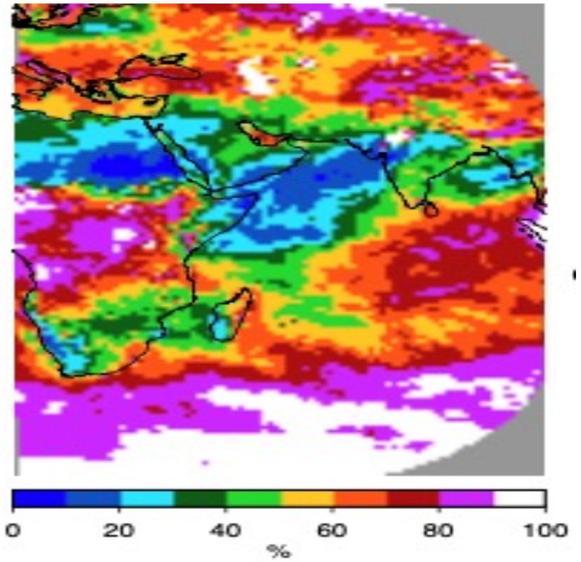
Revisions

1 = Clear/Cloud Threshold Adjustments
4 = Cloud Phase Threshold Fit

Ed 4 (IR Only)
Met-8 [April 2019]

Ocean	54.79
Land	46.02
Cld Frac	50.47

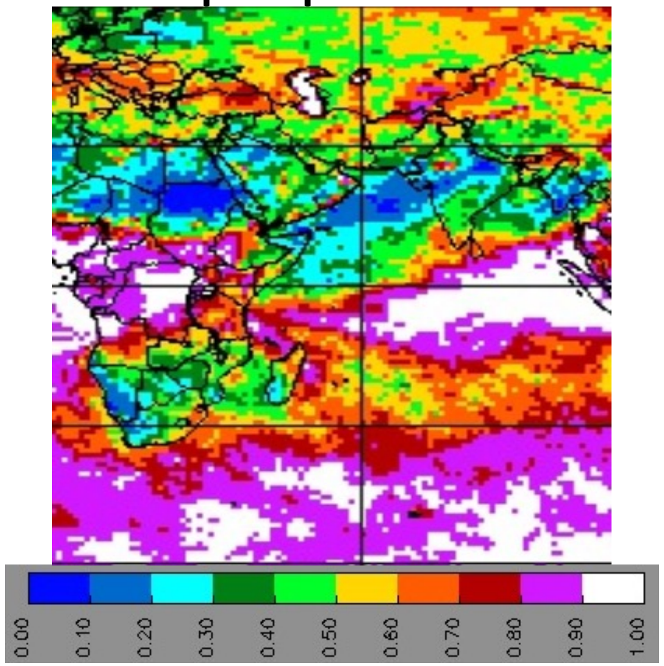




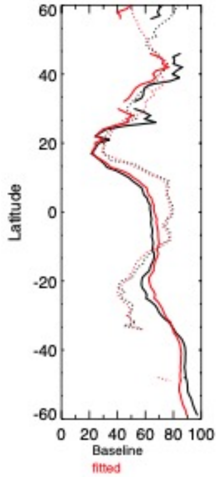
Ed4 Baseline (Multi-Chan)
Met-8 [April 2019]

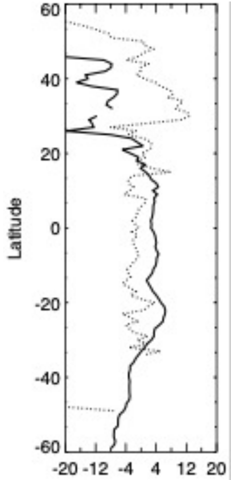
Ocean	69.24
Land	54.27
Cld Frac	61.87

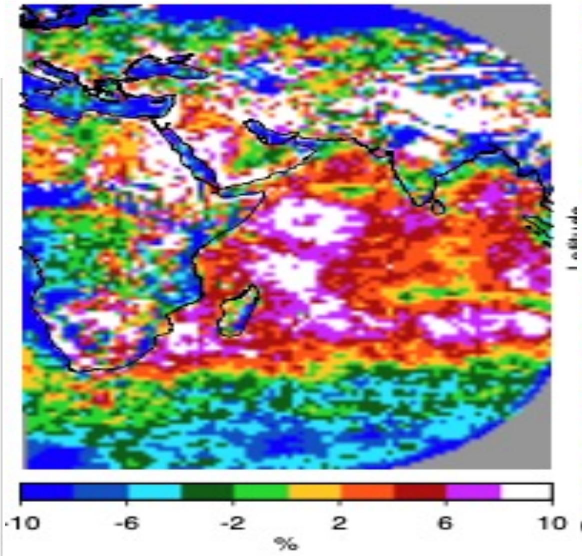
Aqua April 2019

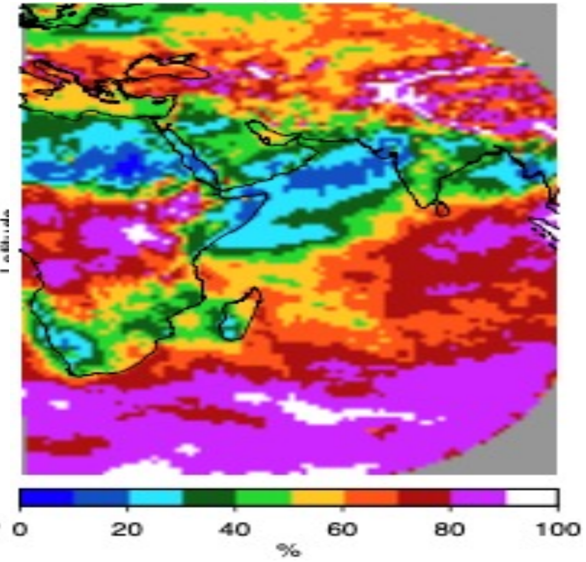


Revision 1&4 - Baseline









Revisions 1 & 4 (IR Only)
Met-8 [April 2019]

Ocean	69.55
Land	54.39
Cld Frac	62.09

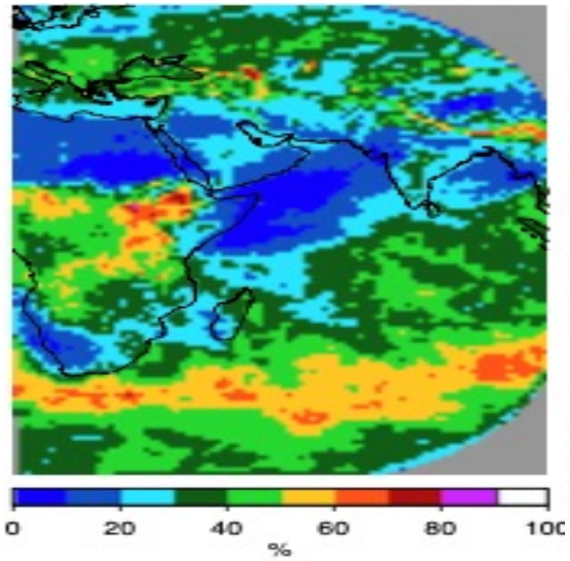
MET-8 Night
Water Cloud Fraction

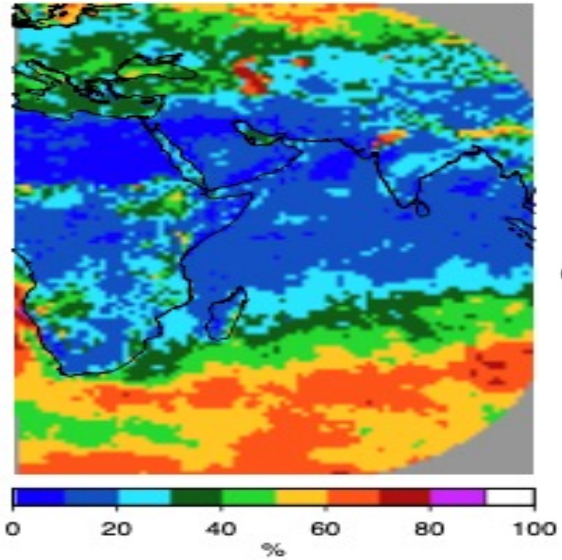
<u>Revisions</u>

1 = Clear/Cloud Threshold Adjustments
4 = Cloud Phase Threshold Fit

Ed 4 (IR Only)
Met-8 [April 2019]

Ocean	37.87
Land	30.32
Cld Frac	34.15

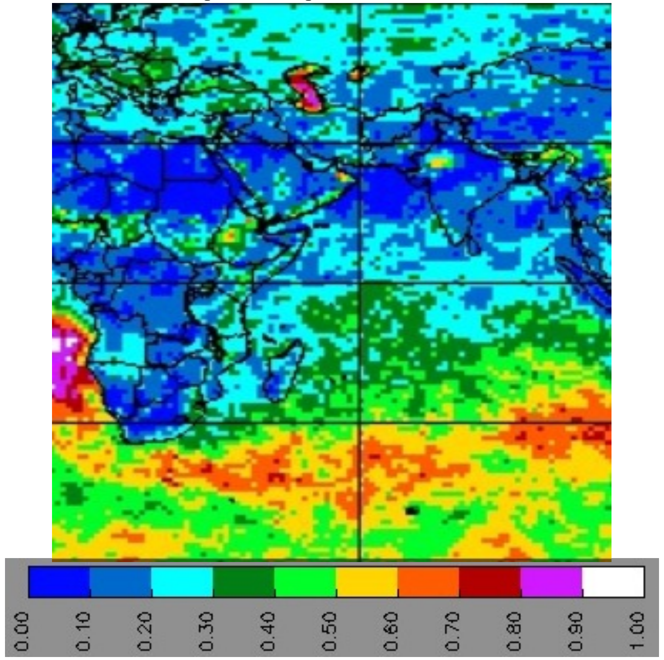




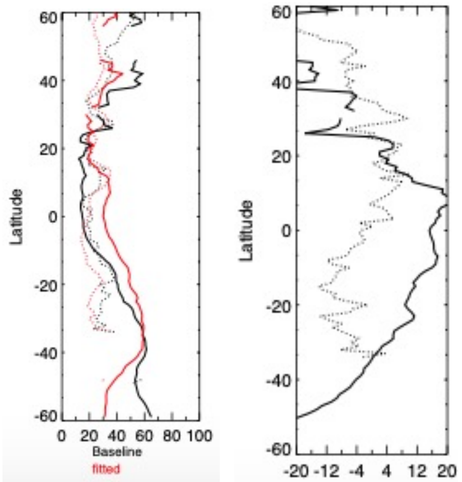
Ed4 Baseline (Multi-Chan)
Met-8 [April 2019]

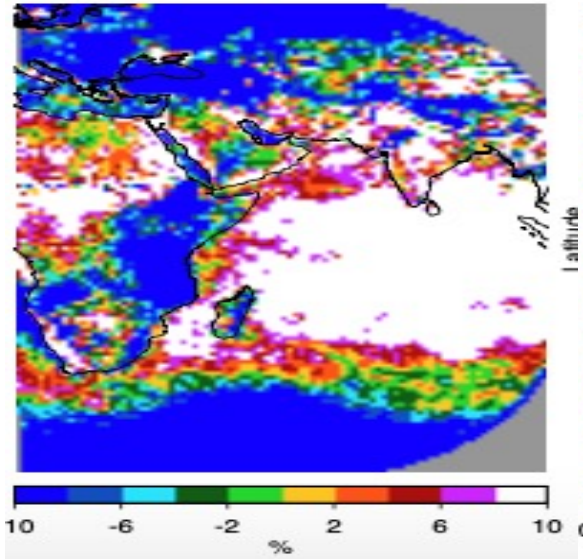
Ocean	40.46
Land	24.22
Cld Frac	32.47

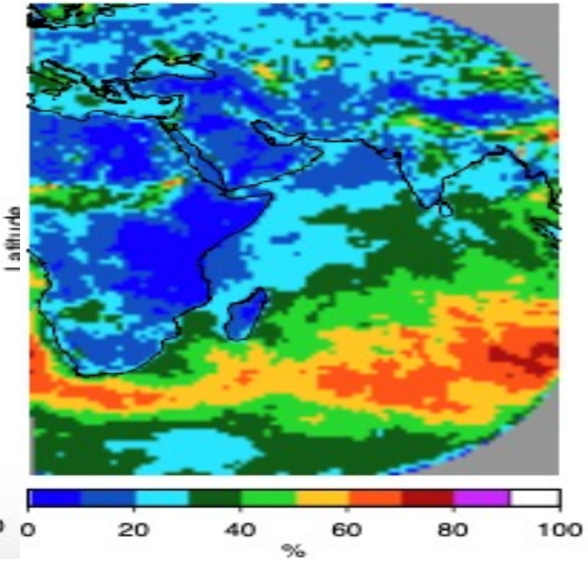
Aqua April 2019



Revision 1&4 - Baseline







Revisions 1 & 4 (IR Only)
Met-8 [April 2019]

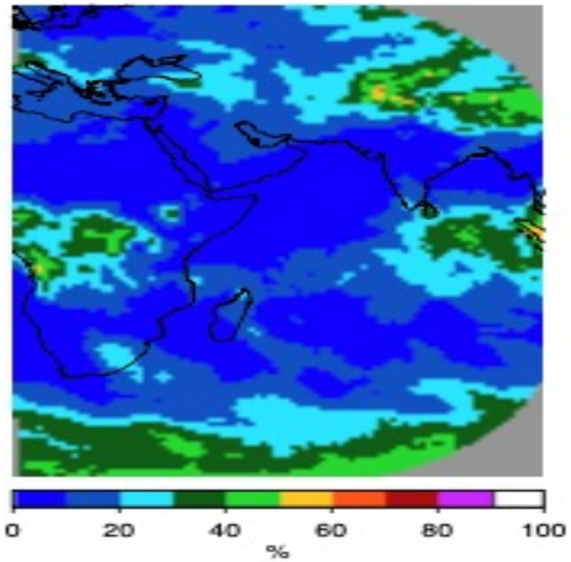
Ocean	41.16
Land	20.15
Cld Frac	30.82

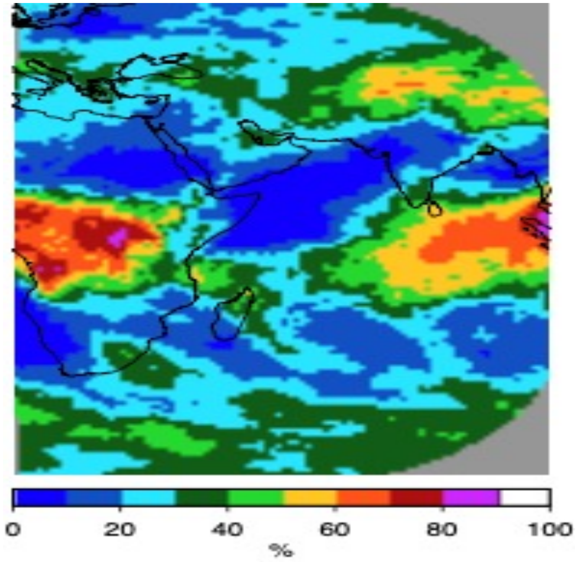
MET-8 Night
Ice Cloud Fraction

Revisions — *1 = Clear/Cloud Threshold Adjustments*
4 = Cloud Phase Threshold Fit

Ed 4 (IR Only)
Met-8 [April 2019]

Ocean	16.91
Land	15.70
Cld Frac	16.32

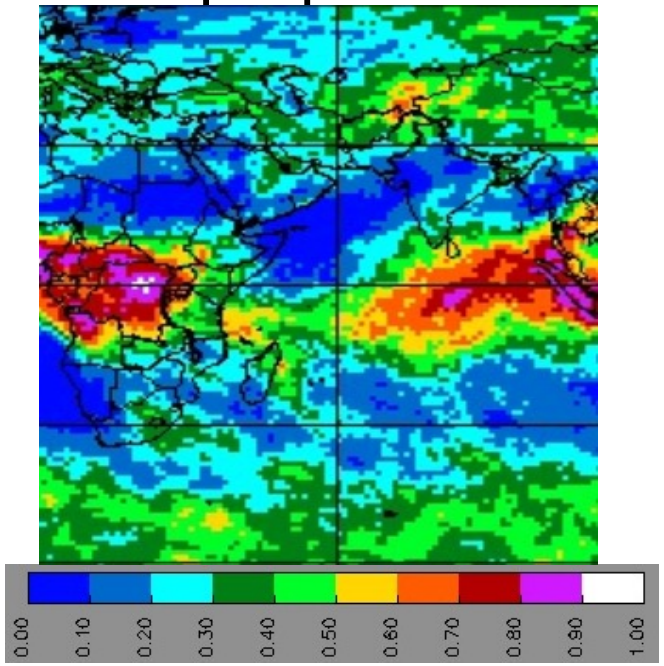




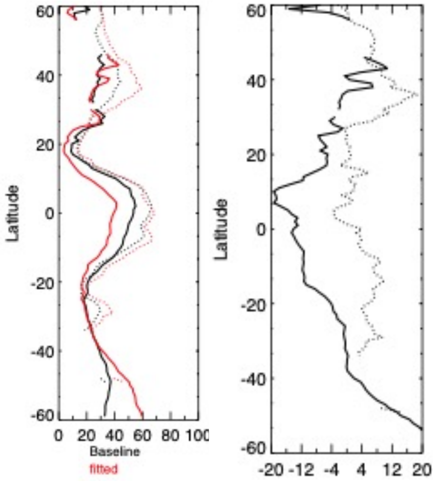
Ed4 Baseline (Multi-Chan)
Met-8 [April 2019]

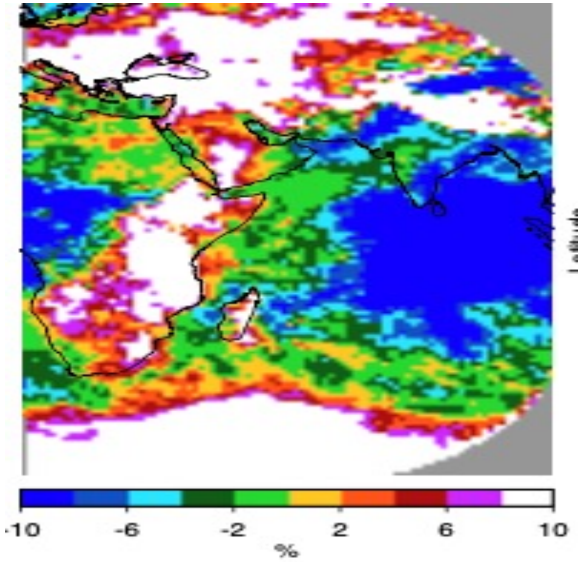
Ocean	28.51
Land	29.45
Cld Frac	28.98

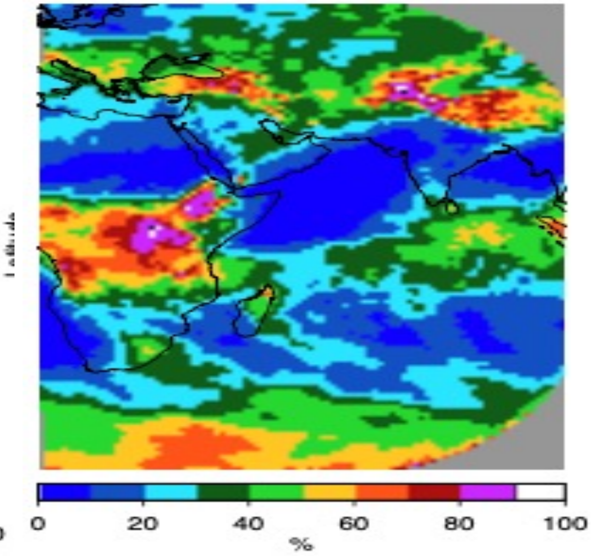
Aqua April 2019



Revision 1&4 - Baseline





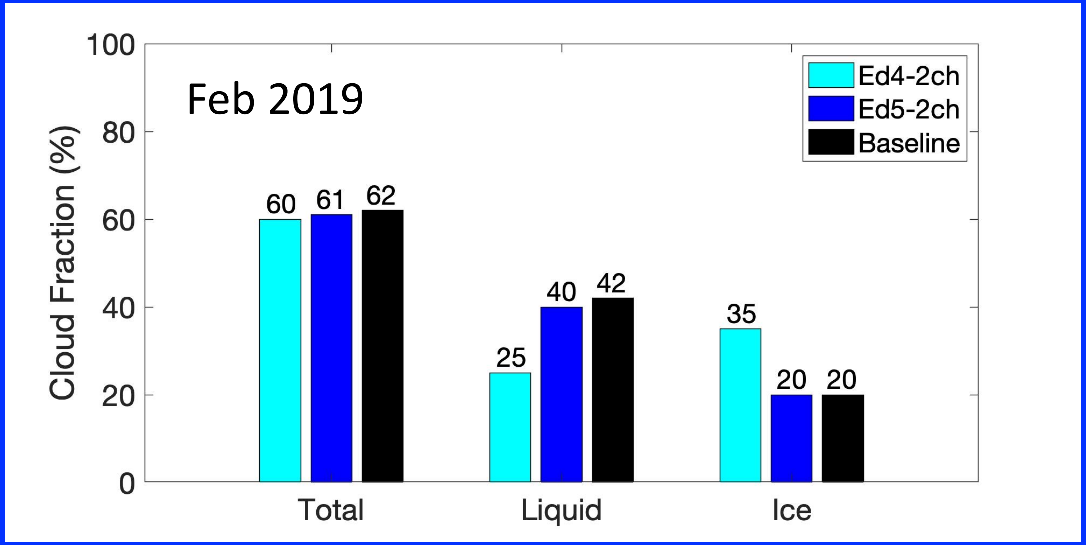


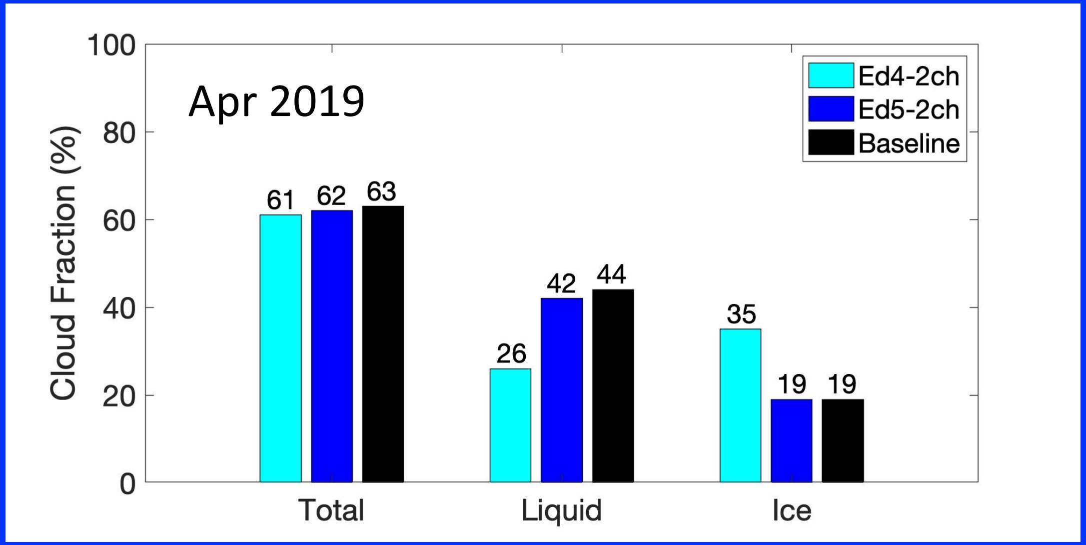
Revisions 1 & 4 (IR Only)
Met-8 [April 2019]

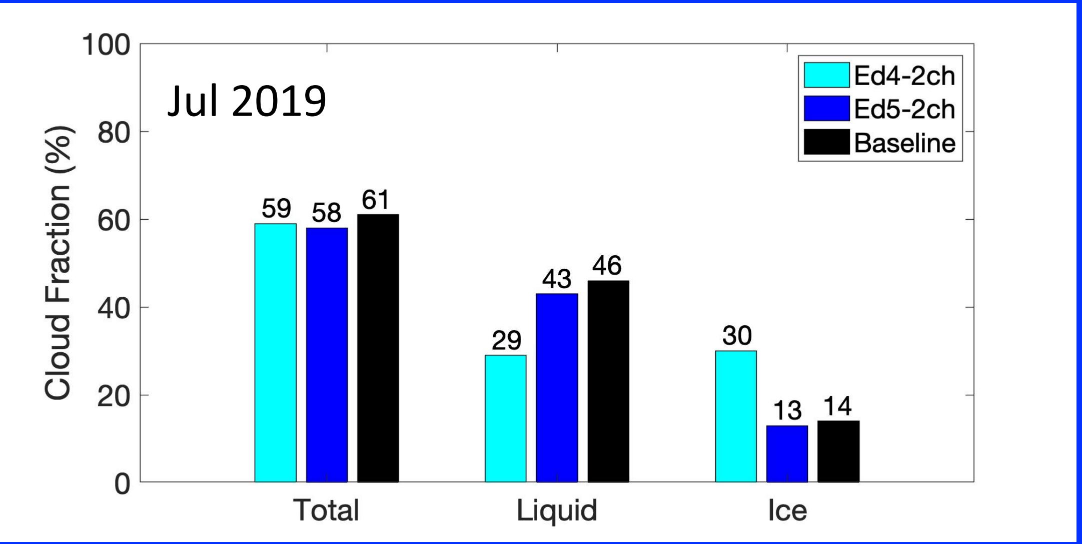
Ocean	28.39
Land	34.23
Cld Frac	31.27

Daytime Cloud Fraction Comparison

(W. Europe GEO Domain Averages)



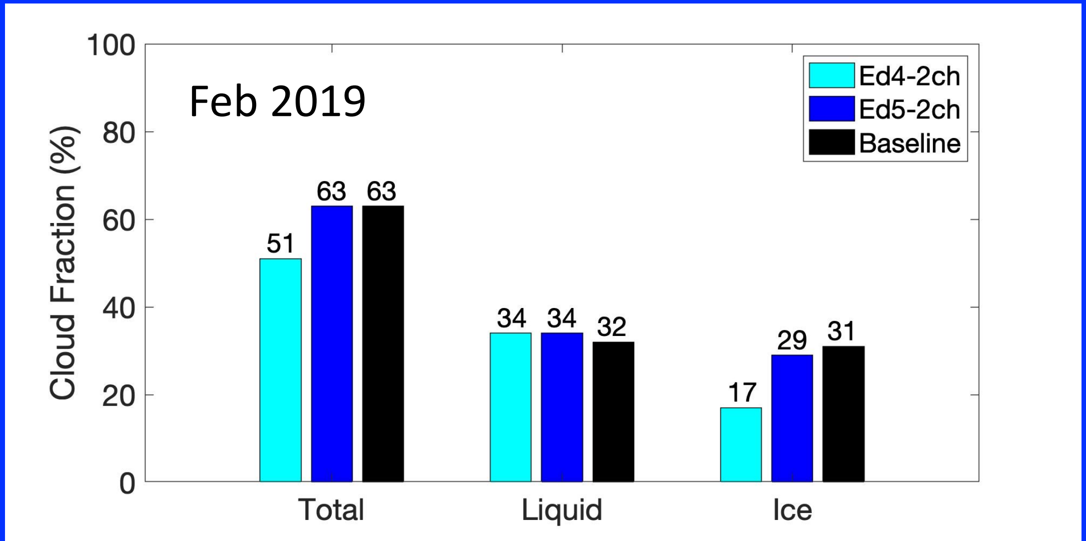


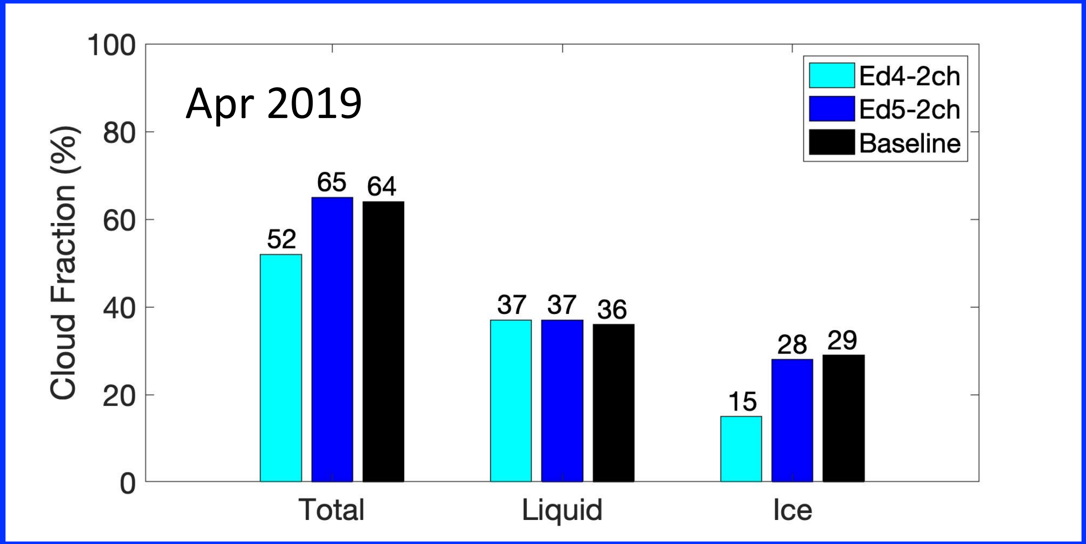


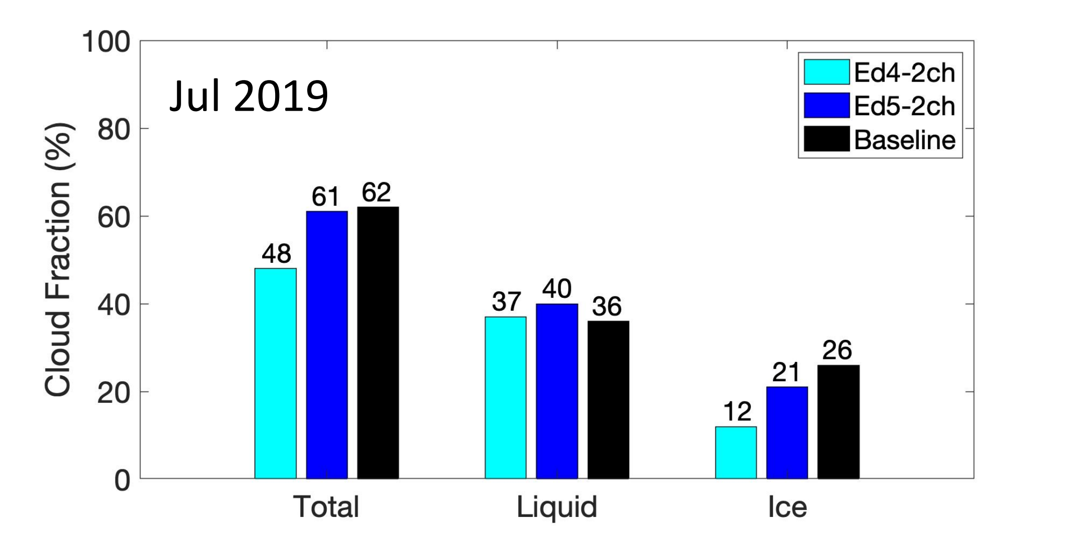
- Daytime total cloud fraction already in good agreement
- Cloud fraction by phase dramatically improved

Nighttime Cloud Fraction Comparison

(W. Europe GEO Domain Averages)







- Nighttime total cloud fraction and cloud fraction by phase dramatically improved

MET-8 Day Total Tau

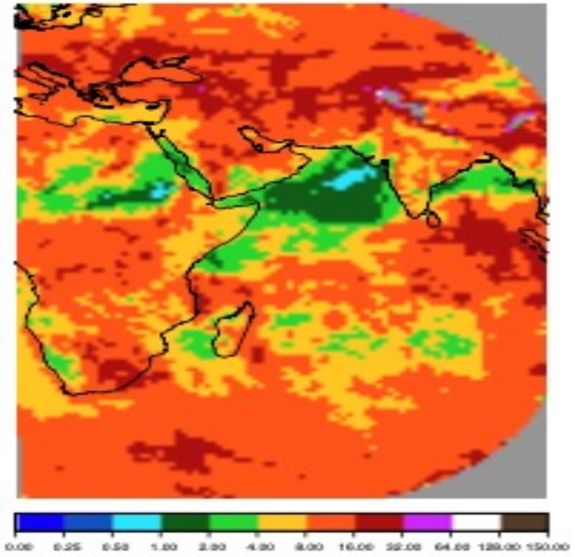
Weighted means

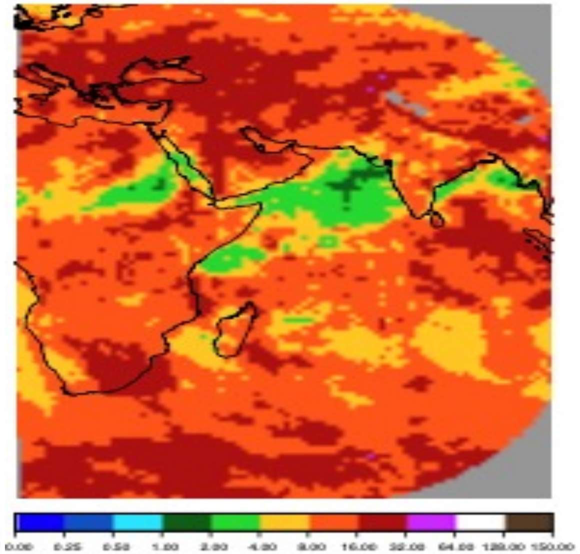
<u>Revisions</u>

1 = Clear/Cloud IR Threshold Adjustments
2 = Revision 1 + mid clouds->water

Ed 4 (2-chan)
Met-8 [April 2019]

Ocean	9.37
Land	10.55

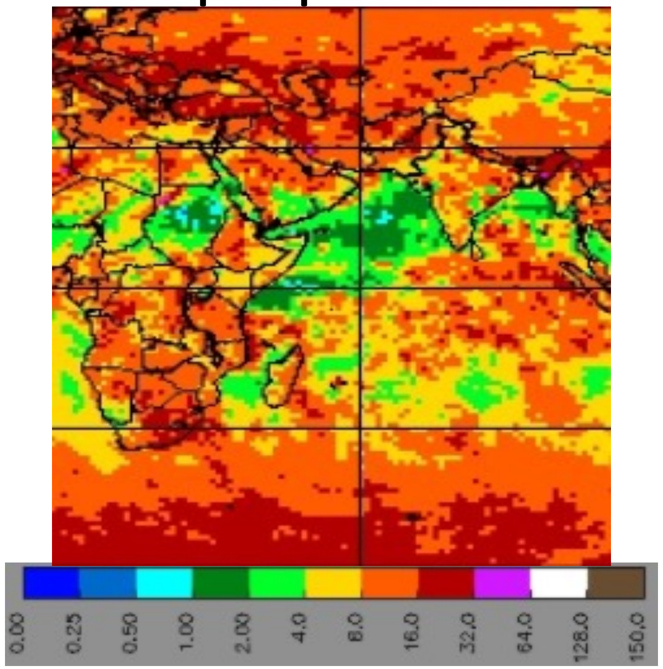




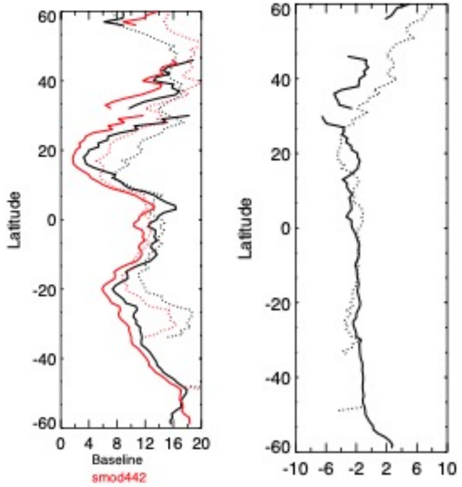
Ed4 Baseline (Multi-Chan)
Met-8 [April 2019]

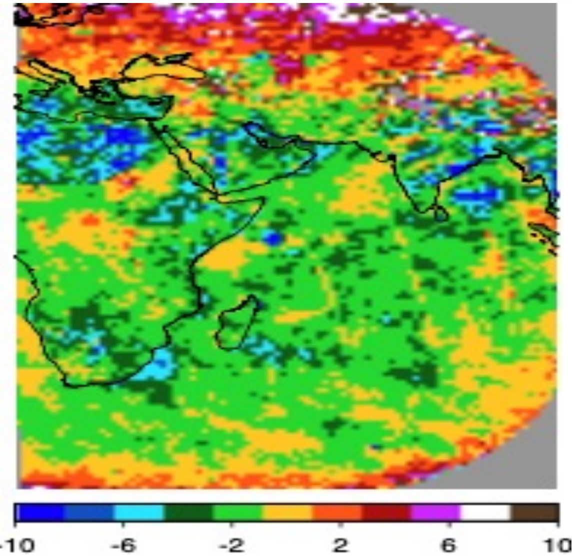
Ocean	11.58
Land	12.80

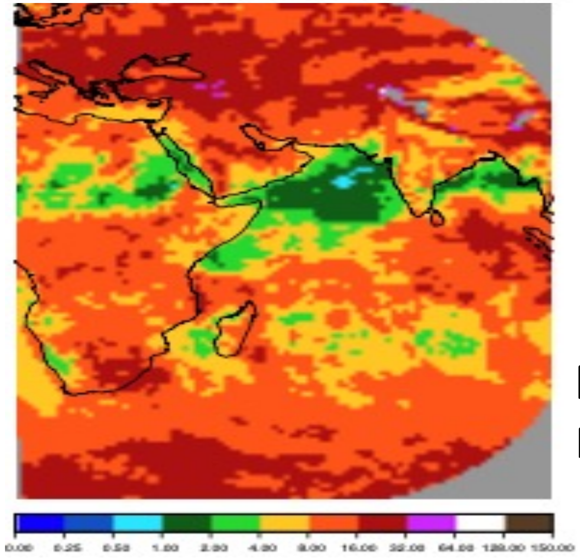
Aqua April 2019



Revision 2 - Baseline







Revision 2 (2-chan)
Met-8 [April 2019]

Ocean	10.12
Land	12.16

MET-8 Day Water Tau

Revisions

1 = Clear/Cloud IR Threshold Adjustments

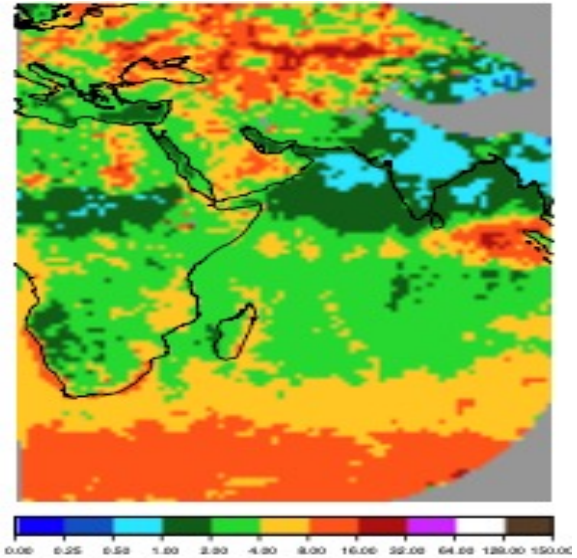
2 = Revision 1 + mid clouds->water

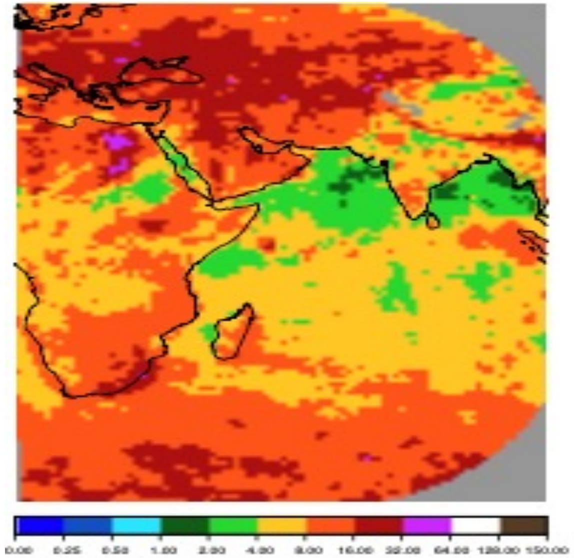
Weighted means

Ed 4 (2-chan)

Met-8 [April 2019]

Ocean	5.36
Land	4.03



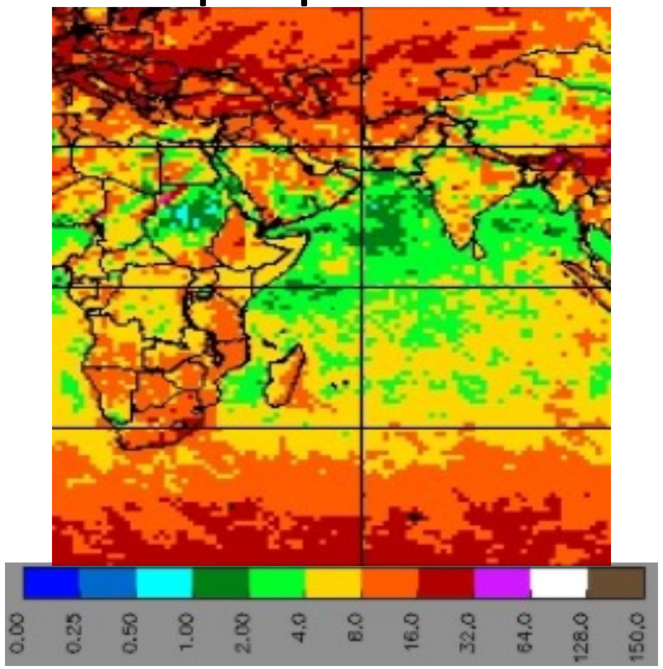


Ed4 Baseline (Multi-Chan)

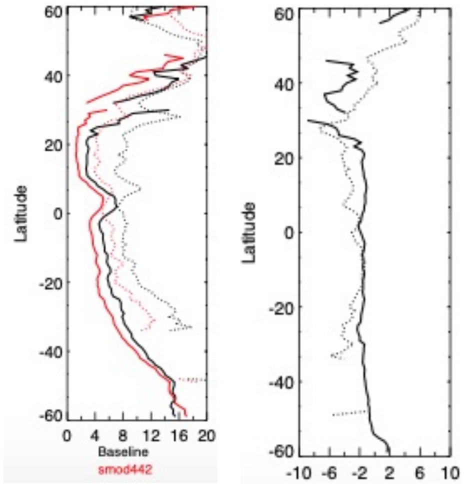
Met-8 [April 2019]

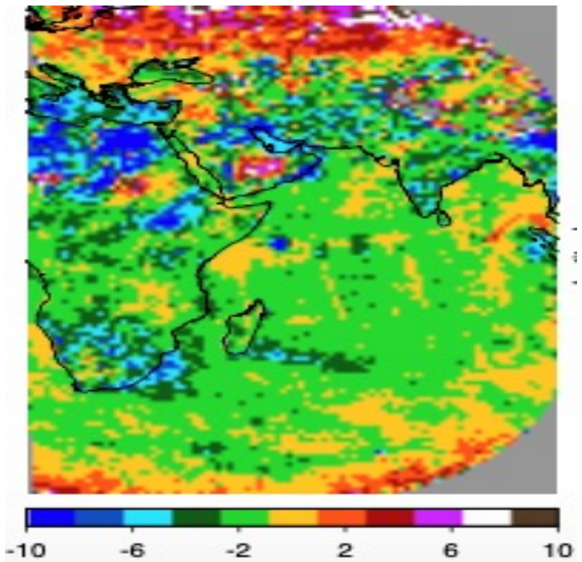
Ocean	8.45
Land	11.16

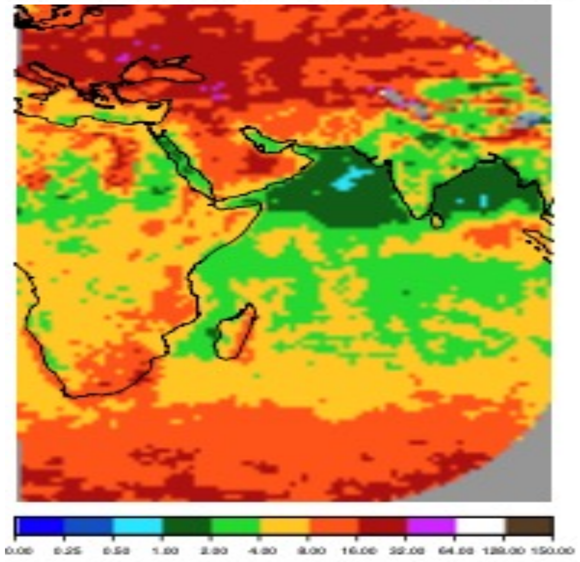
Aqua April 2019



Revision 2 - Baseline







Revision 2 (2-chan)

Met-8 [April 2019]

Ocean	7.06
Land	9.84

MET-8 Day
Ice Cloud Tau

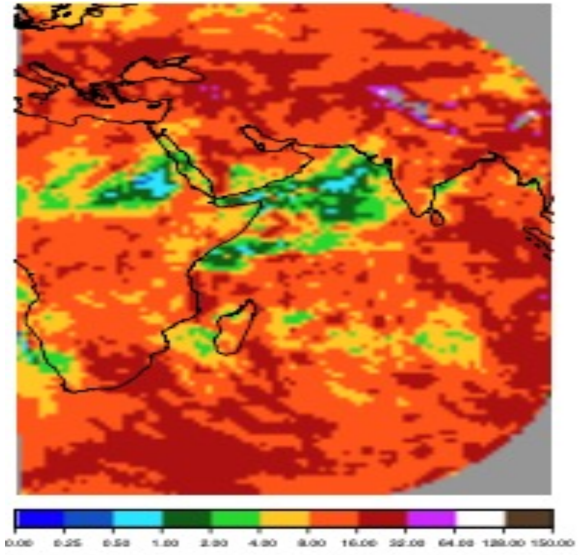
Weighted means

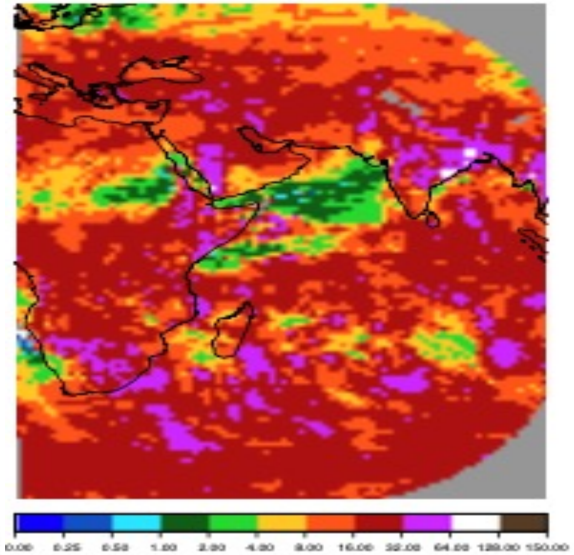
<u>Revisions</u>

1 = Clear/Cloud IR Threshold Adjustments
2 = Revision 1 + mid clouds->water

Ed 4 (2-chan)
Met-8 [April 2019]

Ocean	12.47
Land	12.19

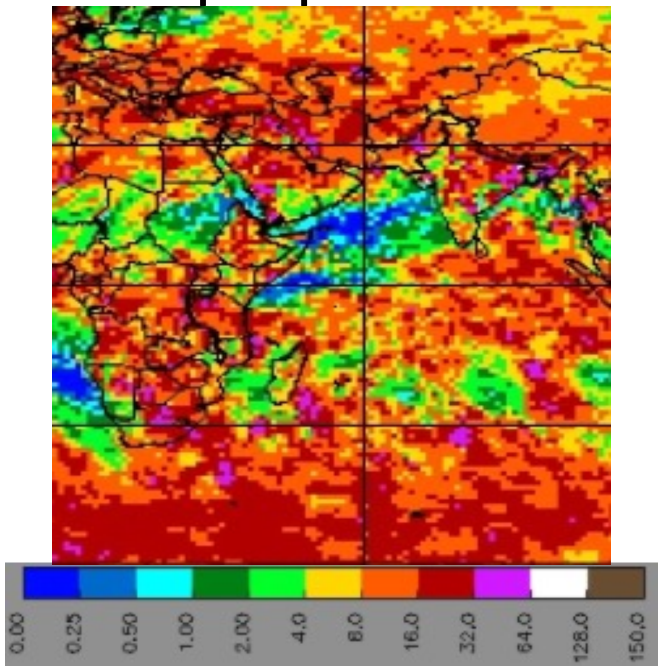




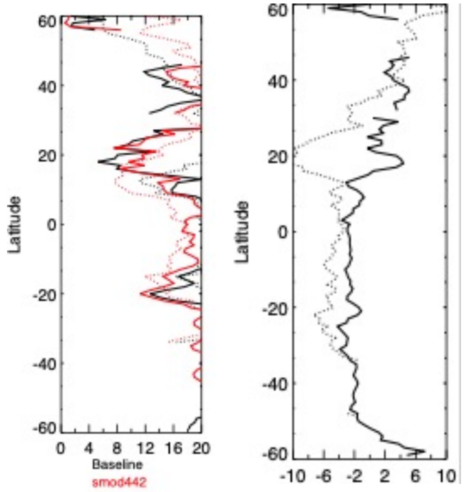
Ed4 Baseline (Multi-Chan)
Met-8 [April 2019]

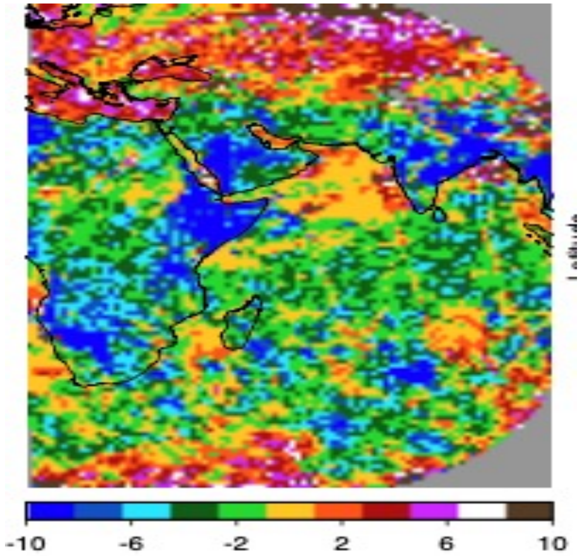
Ocean	18.00
Land	16.60

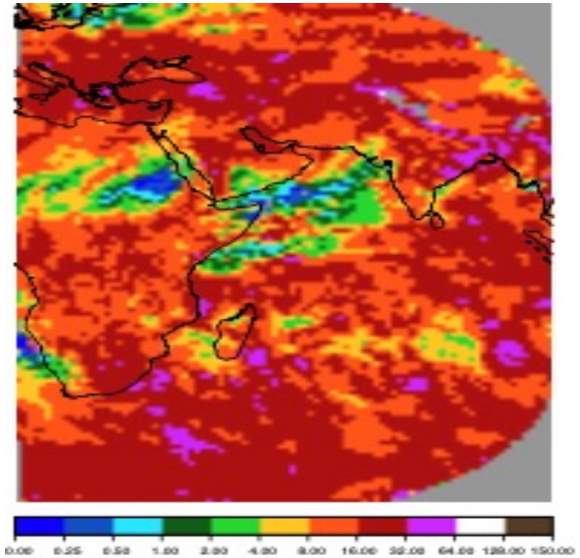
Aqua April 2019



Revision 2 - Baseline







Revision 2 (2-chan)
Met-8 [April 2019]

Ocean	16.58
Land	14.49

MET-8 Day
Water Cloud Z_{eff}

Weighted means

Revisions

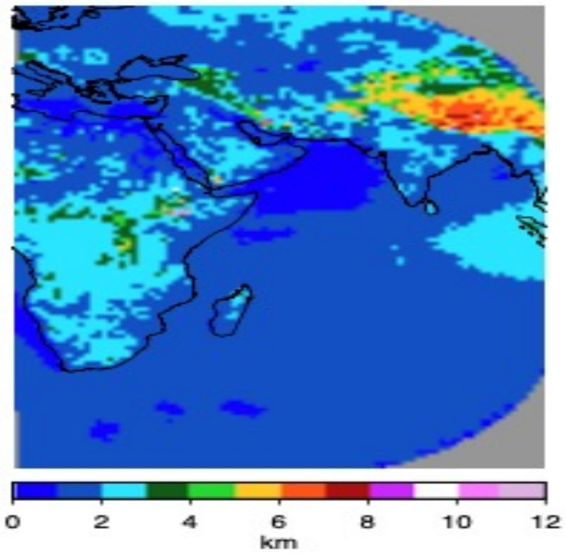
1 = Clear/Cloud IR Threshold Adjustments

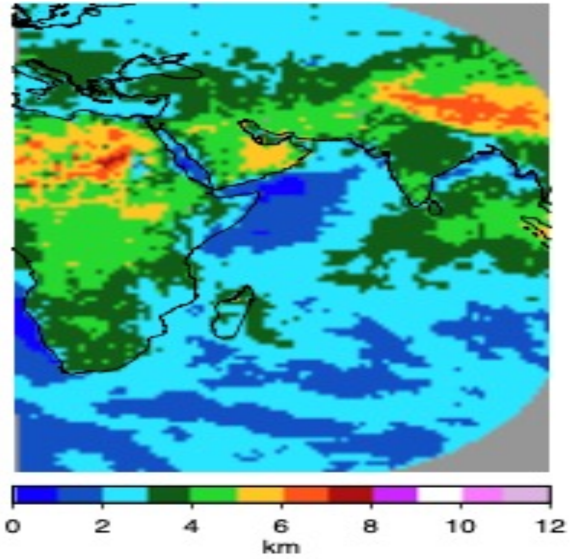
2 = Revision 1 + mid clouds->water

Ed 4 (2-chan)

Met-8 [April 2019]

Ocean	1.25
Land	2.24



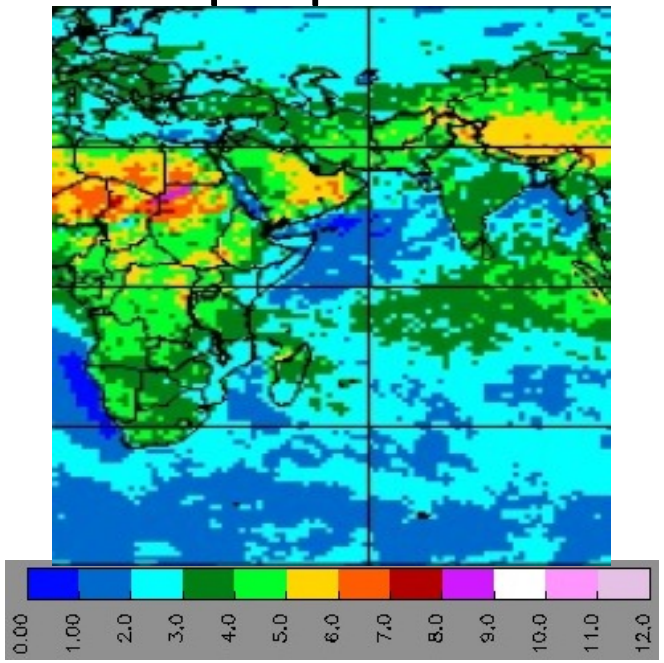


Ed4 Baseline (Multi-Chan)

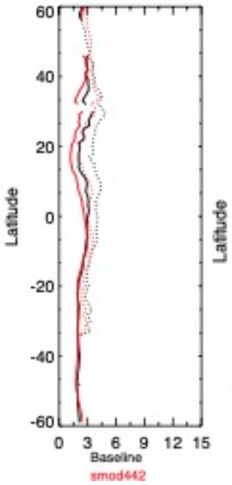
Met-8 [April 2019]

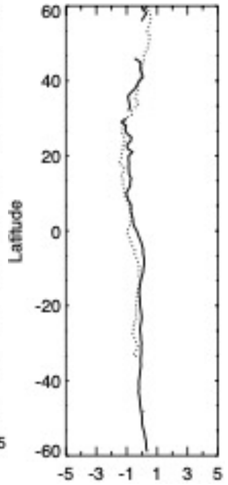
Ocean	2.01
Land	3.23

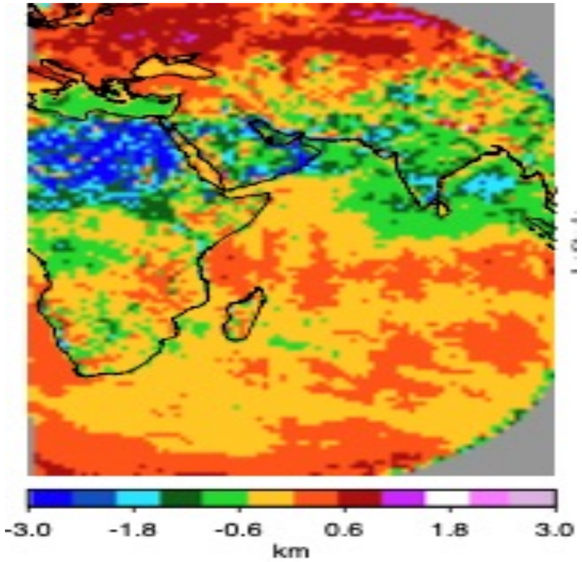
Aqua April 2019

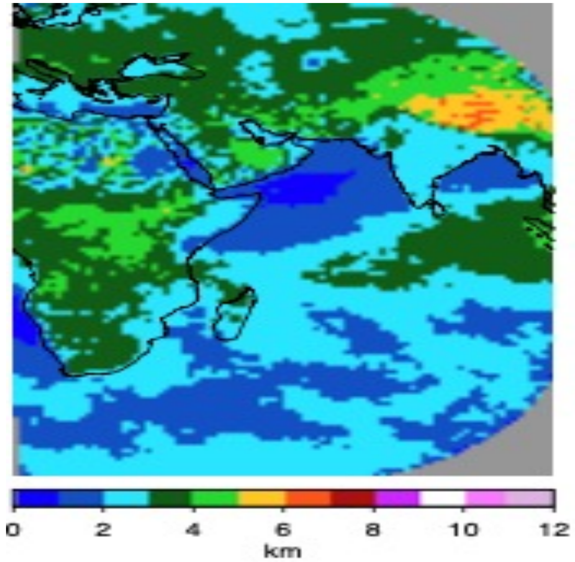


Revision 2 - Baseline









Revision 2 (2-chan)

Met-8 [April 2019]

Ocean	2.06
Land	3.12

MET-8 Day
Ice Cloud Z_{eff}

Weighted means

<u>Revisions</u>

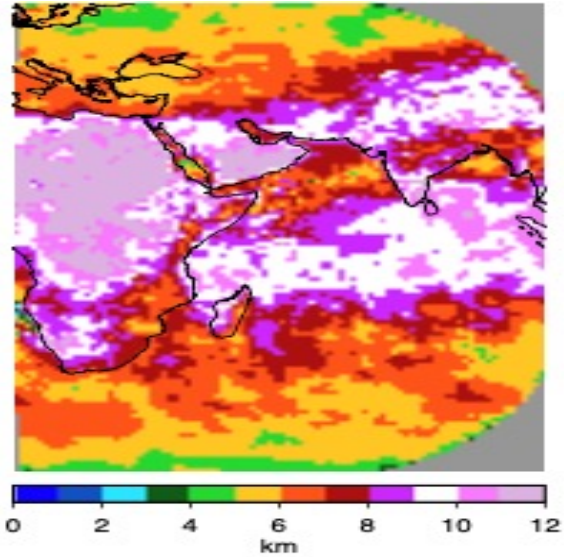
1 = Clear/Cloud IR Threshold Adjustments

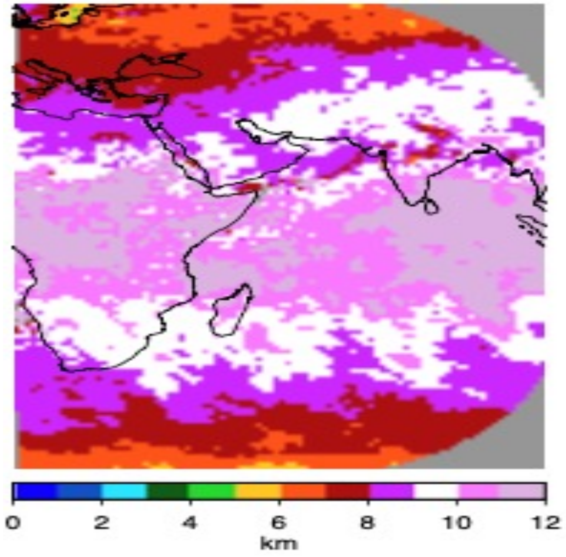
2 = Revision 1 + mid clouds->water

Ed 4 (2-chan)

Met-8 [April 2019]

Ocean	7.12
Land	7.94



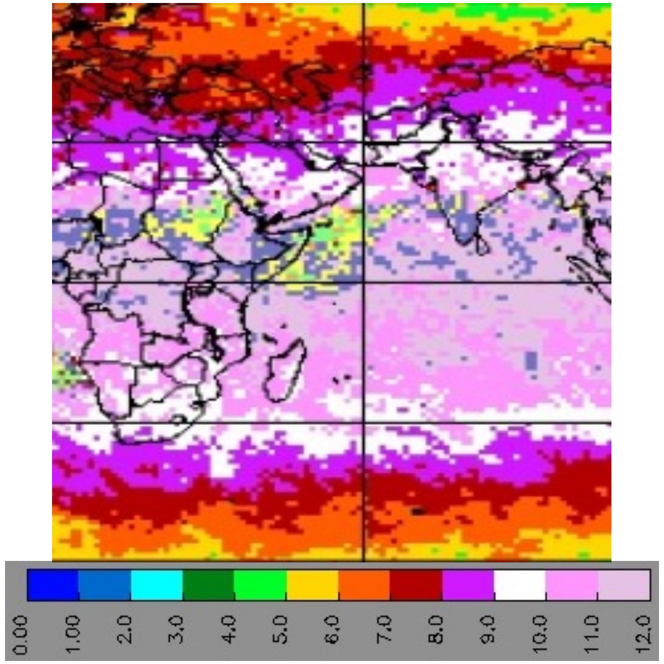


Ed4 Baseline (Multi-Chan)

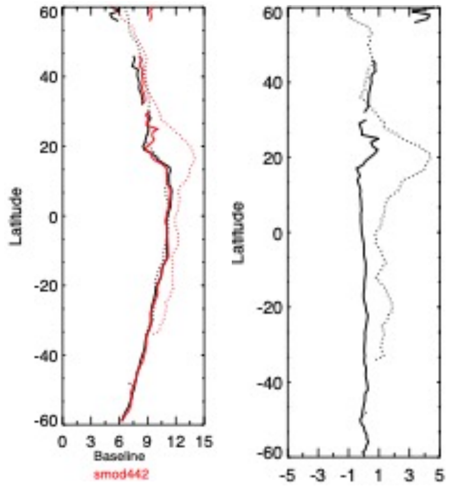
Met-8 [April 2019]

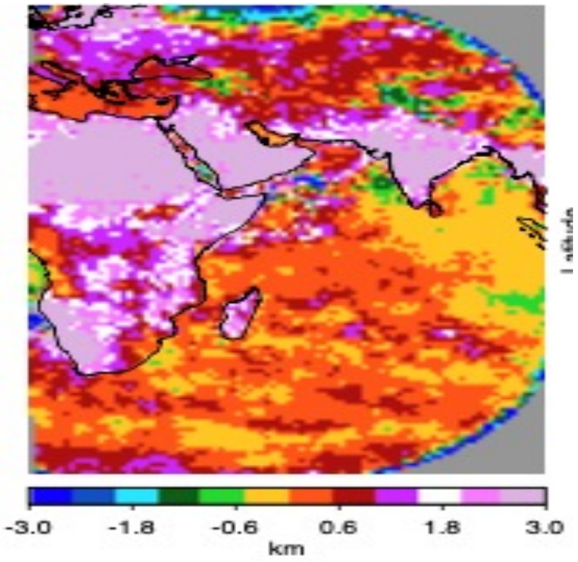
Ocean	8.69
Land	8.26

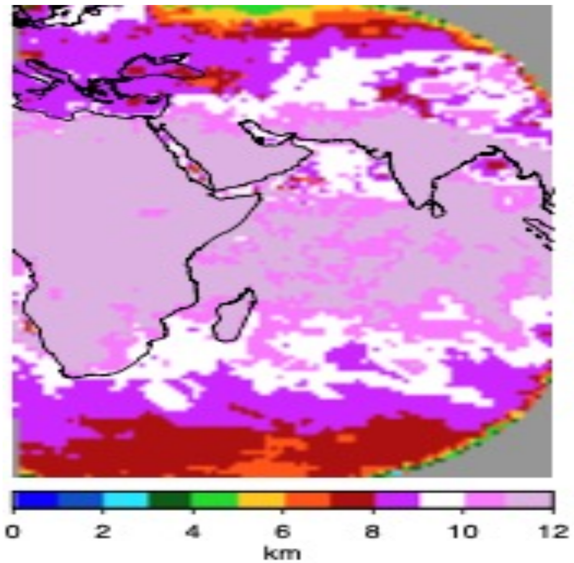
Aqua April 2019



Revision 2 - Baseline







Revision 2 (2-chan)

Met-8 [April 2019]

Ocean	9.48
Land	10.26

Updating Cloud Properties For GEOs With Two Channels

P. Heck, M. Nordeen, B. Shan, C. Yost

Summary

- Simple adjustments to the clear/cloud thresholds and thermodynamic phase dramatically improves the consistency between the derived cloud properties and those derived with more spectral information.
- On the domain-average, the agreement is very good for the three seasonal months tested
- Regional differences are reduced but remain large in some areas
  - Poor cloud/aerosol discrimination
  - Clear sky IR BT and reflectance errors are large (need more accuracy with less spectral info)
  - Different forward models for clouds - No NIR band (cloud models assume fixed effective radius)

Next Steps

- Implement new clear sky reflectances, emissivity's and Tskin Nnet, then re-evaluate
  - derive regionally dependent clear/cloud thresholds from baseline?
- Just started testing a machine learning approach that provides the basis for more accurate and consistent nighttime cloud properties.
- Test on all 2 channel satellites

2022 CWG Publications

*Minnis, P., et al., 2022: VIIRS **Ed1A Clouds Data Quality Summary**, CERES website*

*Smith, W., et al., 2022: VIIRS **Ed1B Clouds Data Quality Summary**, CERES website*

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QUESTIONS ?