



PATMOS-x AVHRR CDR

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PATMOS-x Description (1)

- **Pathfinder Atmospheres Extended (PATMOS-x) is an extension of the 1990's PATMOS project.**
 - PATMOS-x uses a probabilistic cloud detection and optimal estimation cloud algorithms - error estimates are included in output.
 - Ancillary data include the NCEP Reanalysis, OISST v2 and maps of surface emissivity, reflectance and type.
 - PATMOS-x has served as a real-time cloud products system at NESDIS since 2002.
 - PATMOS-x Cloud CDR's have been submitted to the GEWEX Cloud Climatology Assessment and participated in ESA/CCI.
 - Data is processed at UW/CIMSS.
- **AVHRR has no on-board calibration for solar-reflectance channels. The PATMOS-x group was funded to develop a solar-reflectance calibration (SOLCAL) FCDR under the NCDC SDS program.**
 - SOLCAL covers 0.63, 0.86 and 1.6 micron observations.
 - SOLCAL is tied to MODIS Collection 5 calibration via direct comparison during SNO's and through observations of stable ground targets.
 - SOLCAL has been submitted GSICS and has been adopted by the EUMETSAT CM-SAF group.

PATMOS-x Description (2)

- **The PATMOS-x SOLCAL FCDR's have been hosted at NCDC since 2010.**
 - The PATMOS-x SOLCAL FCDR delivery to NCDC covers all AVHRR GAC Data (1978-2009)
 - PATMOS-x generates pixel-level 4km level2 files but our NCDC deliveries have been level2b data at a resolution of 0.1 degree. Original hdf4 data was converted to netcdf by NCDC.
 - A delivery of recent data with updated calibration will occur this summer, bringing the NCDC record up to present.
 - A near-real time daily delivery system will also go into effect this summer.

Project Description

CDR(s) (Validated Outputs)	Period of Record	Spatial Resolution; Projection information	Time Step	Data format	Inputs	Uncertainty Estimates (in percent or error)	Collateral Products (unofficial and/or unvalidated)
0.63, 0.86 μm TOA Reflectance	1978- present	4km GAC and sampled at 0.1 degree	1x per day before 1991. 2x: 91-02 3x+:02-12	Level2: 4km Level2b: 0.1°	GAC Level- 1b + Ancil Data		Cloud and Aerosol Opd. NDVI Atmos Corr Reflectance
1.6 μm TOA Refl.	2002-12	4km GAC and sampled at 0.1 degree	1x: 02-06 2x:06-12	Level2: 4km Level2b: 0.1°	GAC Level- 1b + Ancil Data		Cloud Part Size.
Cloud Probability (<i>not a cdr but probably needed for FCDR support</i>)	1978- 2012	4km GAC and sampled at 0.1 degree	1x per day before 1991. 2x: 91-02 3x+:02-12	Level2: 4km Level2b: 0.1°	GAC Level- 1b + Ancil Data		

Production Approach (1)

- PATMOS-x Solar Calibration:
 - Periodically (annually), MODIS and AVHRR SNO data and AVHRR data over stable targets are computed.
 - Calibration coefficients are recomputed for each appropriate sensor using all of the data (including the new data)
 - New calibration curves are compared to old calibration curves.
 - Stability of SOLCAL is monitored by stability of cloud optical depth and particle size time-series.
 - Specific Challenges
 - PATMOS-x SOLCAL should be redone completely using the soon to be released MODIS Collection 6 calibrated data.
 - Lack of GAC data for some early sensors limits the ability of the PATMOS-x SOLCAL approach to test sensor to sensor consistency.

Production Approach (2)

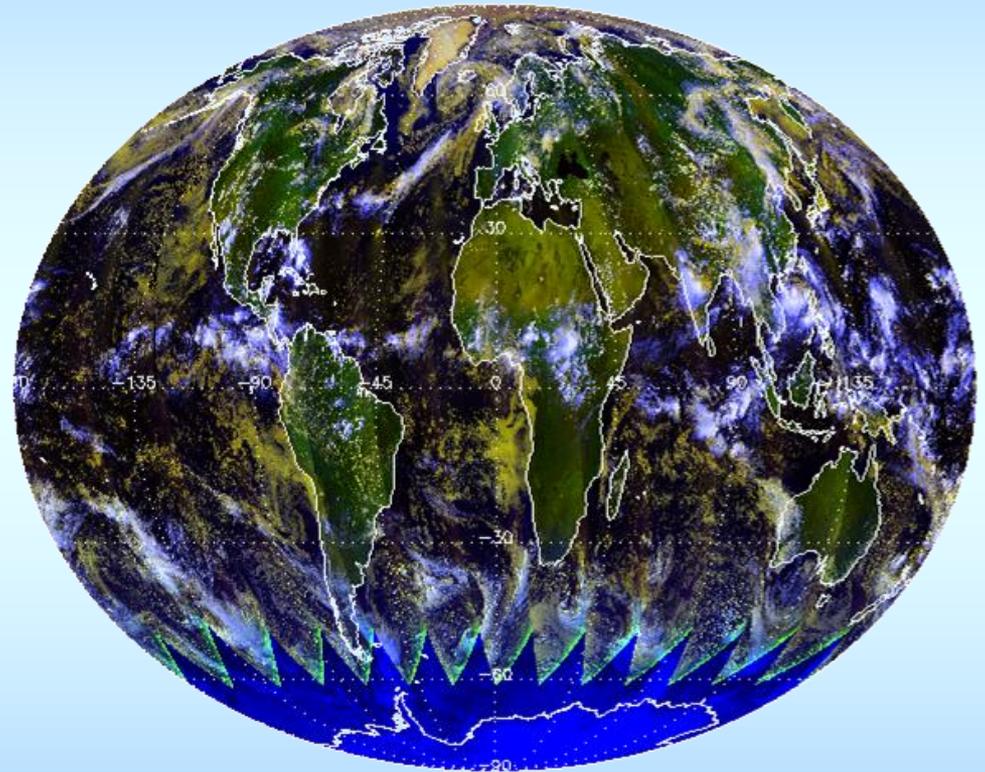
- PATMOS-x CDRs:
 - In 2010, we processed the entire NESDIS GAC Level-1b archive at UW/CIMSS and transferred all data to NCDC.
 - In 2012, we will begin daily updates.
 - Plans are to move production to NCDC and code modifications to achieve that goal are being formulated by NCDC.
 - Cloud CDRs are compared to those from advanced sensors (MODIS and CALIPSO) and time series are compared to other data sets through GEWEX. Detailed comparisons are being carried out with CM-SAF GAC cloud products.
 - Specific Challenges
 - The PATMOS-x SOLCAL FCDRs are provided without any cloudiness information. Our experience indicates that this limits their use for most applications. At a minimum cloud screening is needed. Land masks, snow/ice masks and viewing geometry are also recommended.
 - Entire PATMOS-x data is available but not through an interface that allows spatial, temporal or parameter sub-setting. It would be a challenge for some to grab the FCDRs and then the needed data from the other archive.

Routine Daily PATMOS-x Updates

- Our Fy2012 activity includes the automatic delivery of PATMOS-x data to NCDC.
- We can reliably accomplish this with data delay of 2 days. The data is driven by the availability of our ancillary data (CFSR and OISST v2).
- PATMOS-x daily processing has begun this week.
- Tools to create netCDF data for NCDC are still being developed.
- Calibration for the near real-time processing is extrapolated.

Example image from new near real-time processing

patmosx_n18_asc_2012_204.level2b



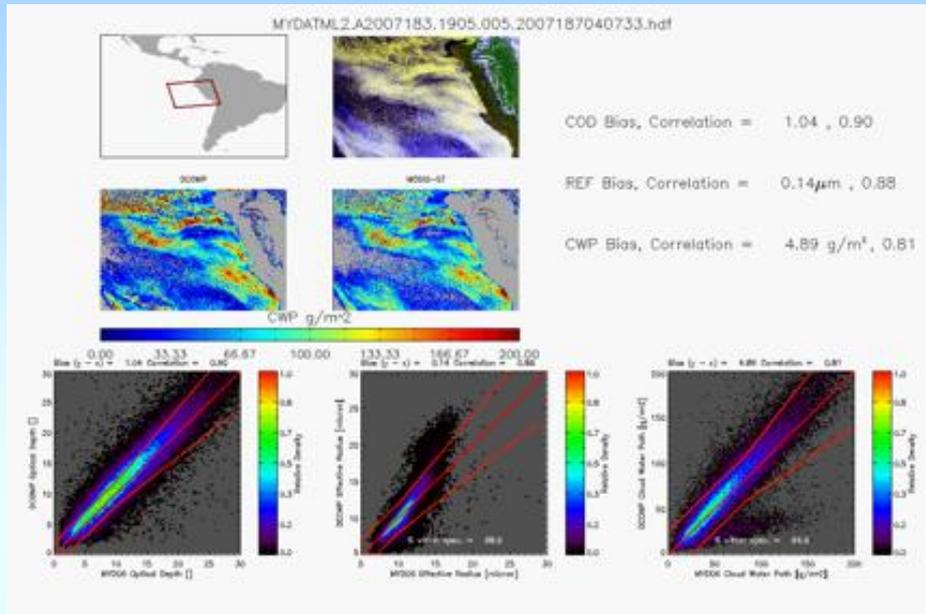
False Color Image

Red=0.63 μ m, Green = 0.86 μ m, Blue = 11 μ m (reversed)

Quality Assurance Approach

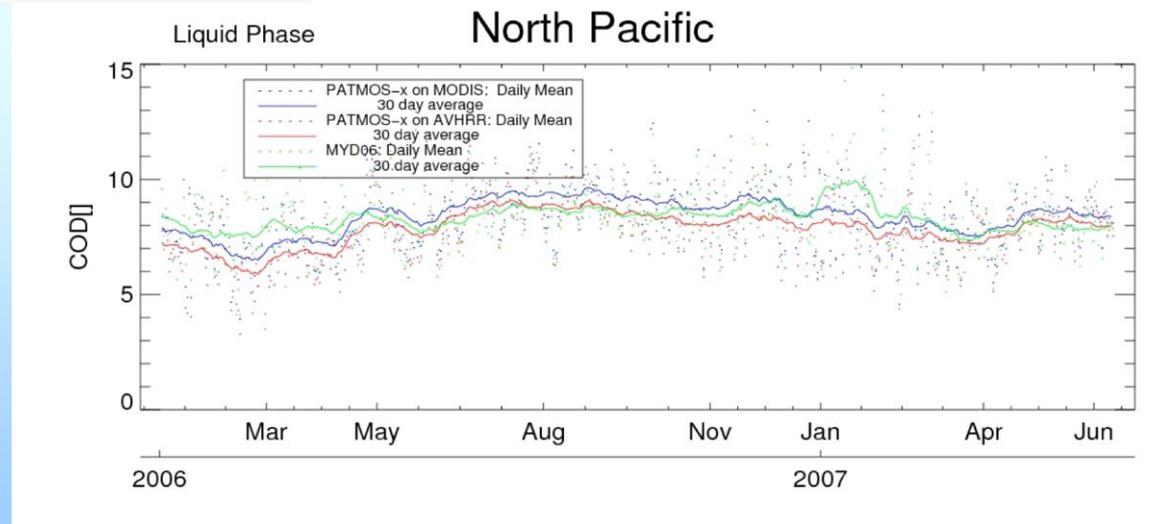
- Instantaneous and long-term validation against independent data (MODIS, GOES, VIIRS)
- Participation in community projects designed to test the fidelity of the PATMOS-x record
 - GEWEX
 - CCI
 - SCOPE-CM
- Monitoring tools developed specifically for CDR program
- Integration of QA metrics into processing to be output as attributes

Quality Assurance Approach



Instantaneous comparisons to MODIS during period of simultaneous data provide FCDR and product assessments over a wide dynamic range. MODIS data is MCST C5.

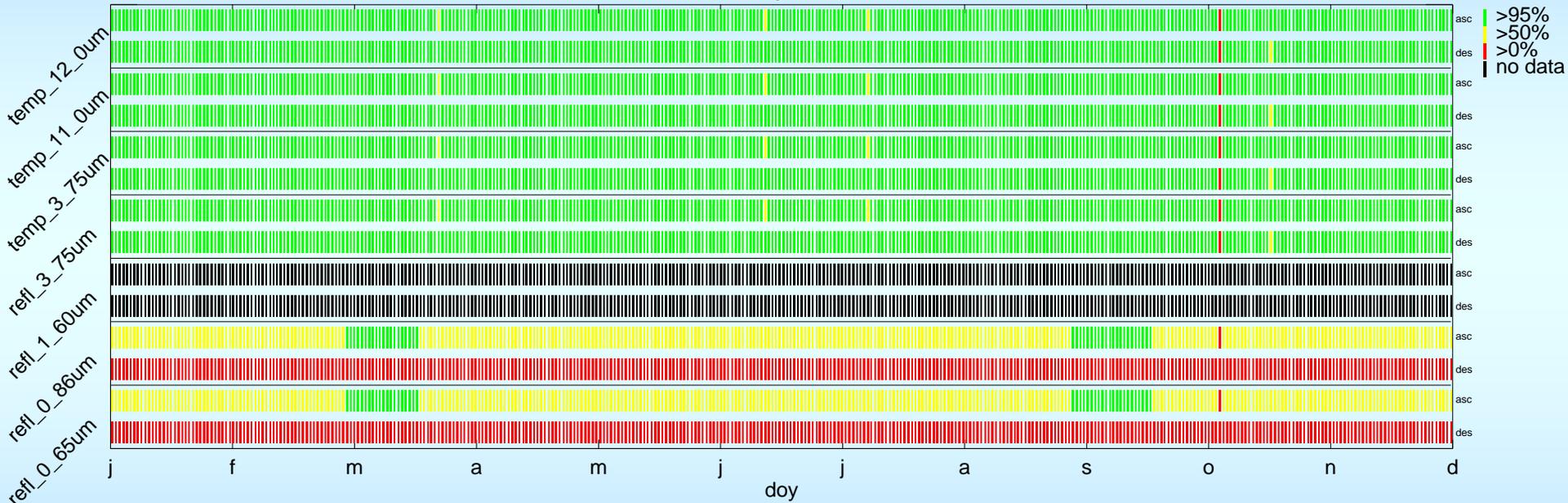
Longer-term comparison to demonstrate stability of FCDR and derived products (cloud optical depth)



Quality Assurance Approach (daily)

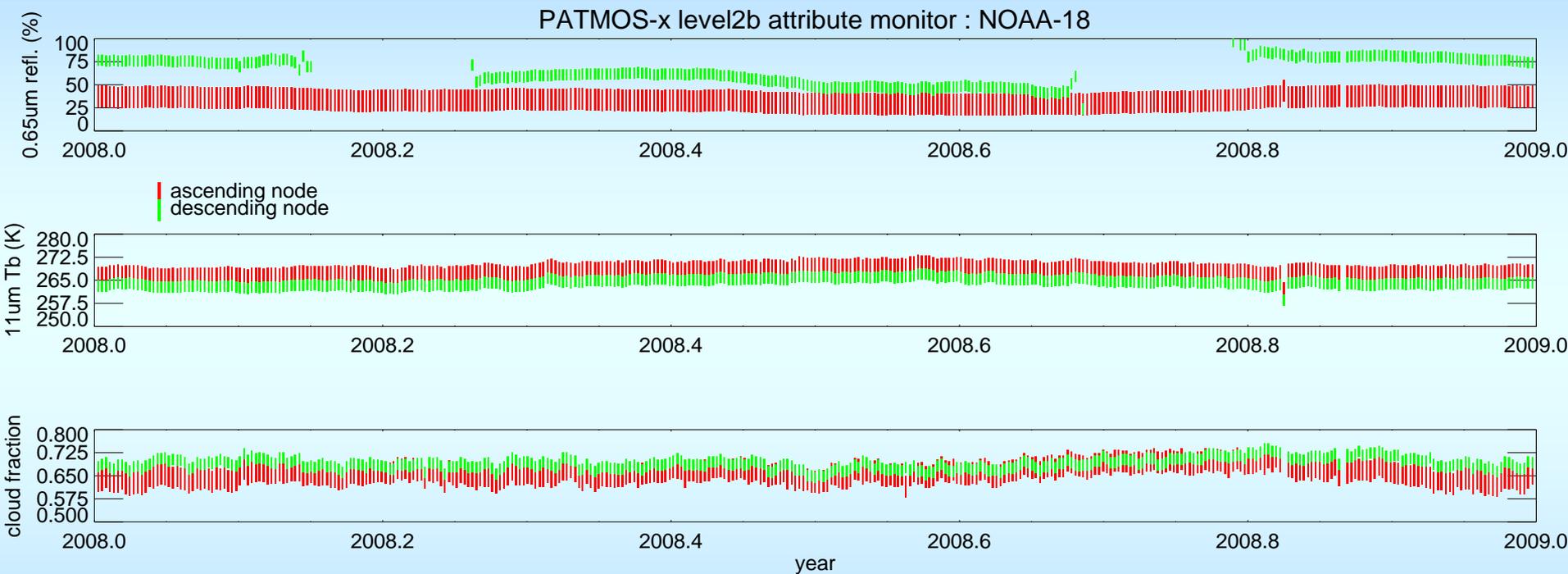
CDR-specific monitoring tools

valid data dashboard - year: 2008 satellite: n18



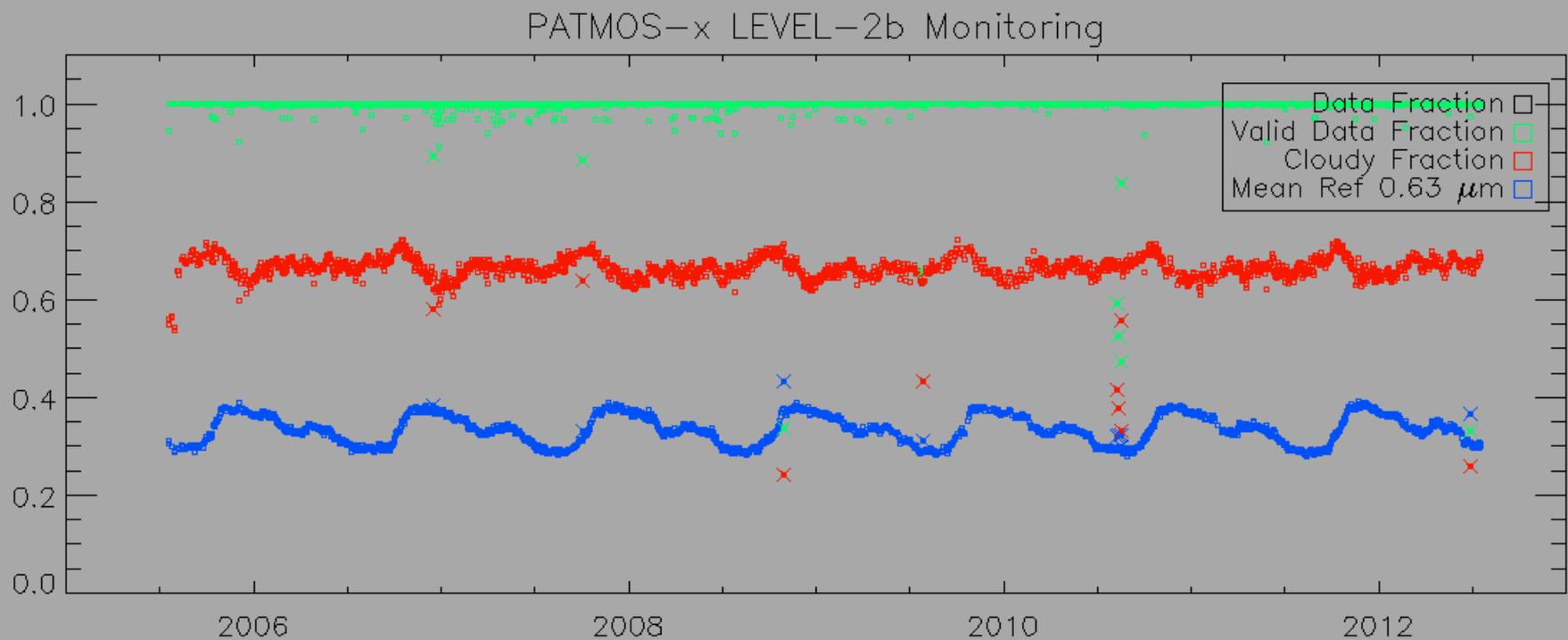
Quality Assurance Approach (daily)

Integration of QA metrics as attributes



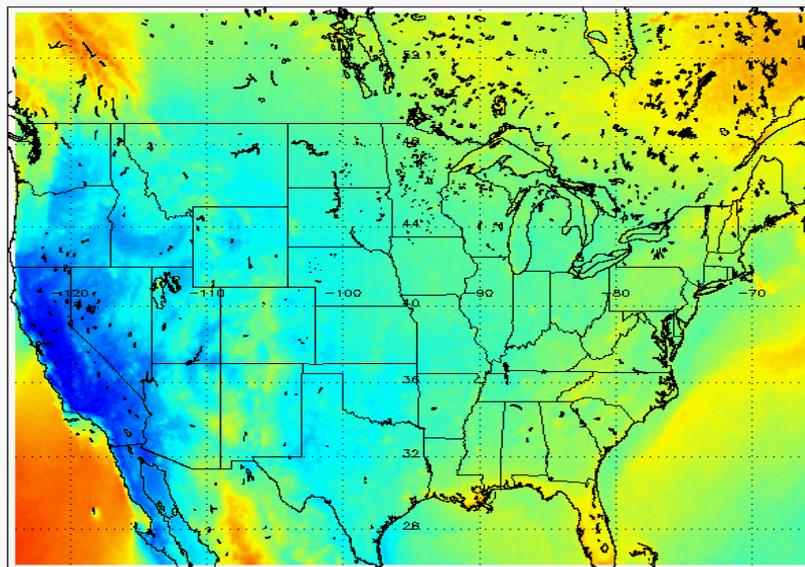
Quality Assurance Approach (daily)

NOAA-18 Ascending Node Results for Entire Operational Life

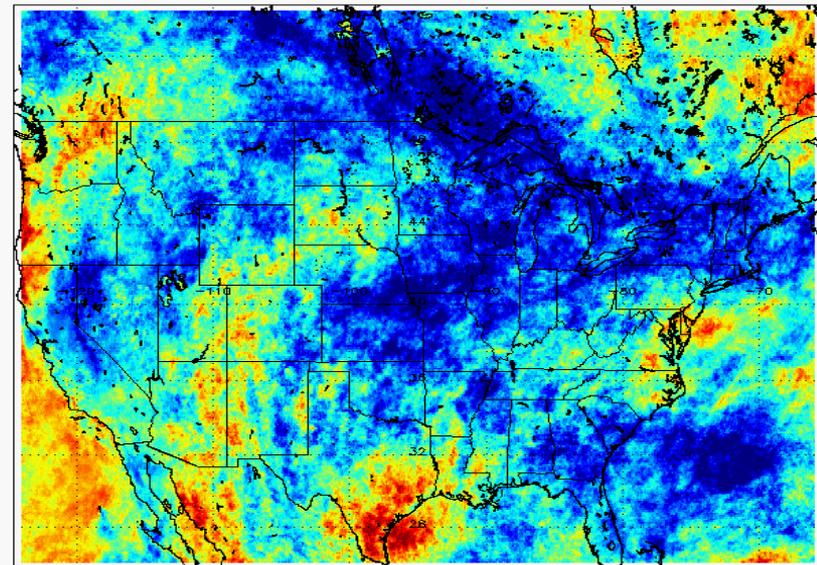
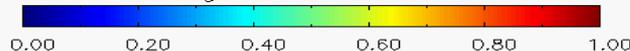


Quality Assurance Approach (monthly)

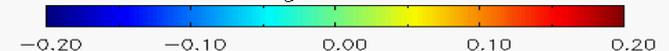
- We propose the automatic generation of monthly anomaly maps of key CDRs.
- Images below show climatological mean (1982-2011) cloud fraction and the 2012 anomaly for July (note the dearth of cloud in midwest)
- The images are generated using Level2b data as delivered to NCDC (no spatial averaging).
- Can be implemented with data from daily updates. We suggest the generation of rolling 30-day anomalies.



climatological mean cloud_fraction



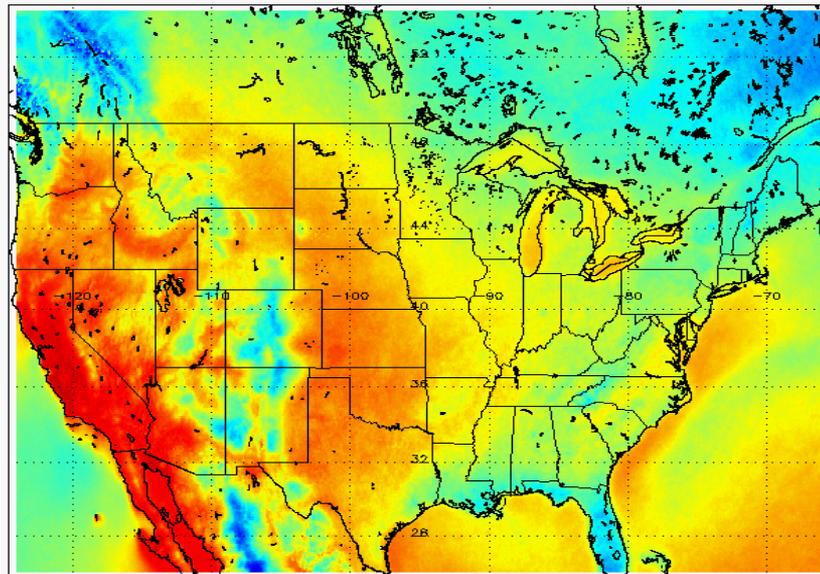
2012 - climatological mean cloud_fraction



Applications

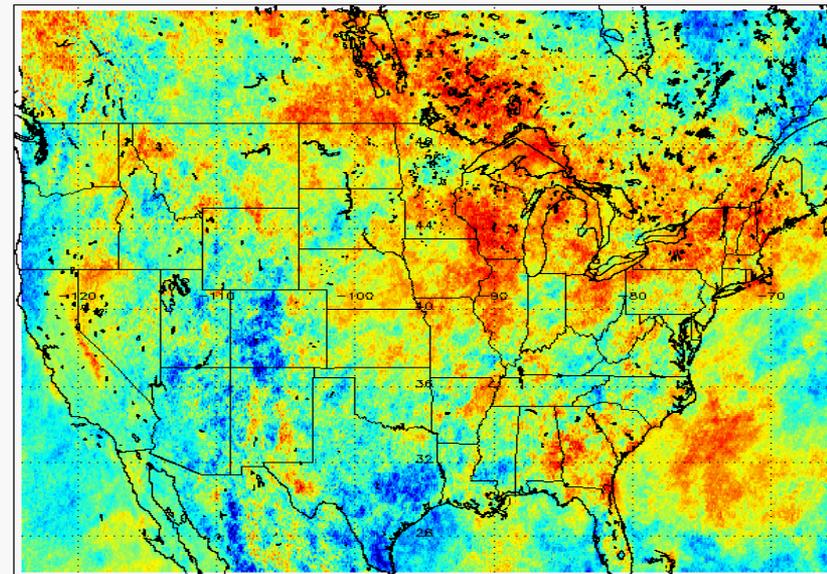
Solar Energy

- PATMOS-x has supplied NREL with satellite derived solar energy estimates from GOES (2005-2010) using the NESDIS Operational Approach (I. Laszlo)
- AVHRR PATMOS-x provides higher spatial resolution data from a longer period (1982-2012).
- Images below show cloud transmission which is the dominant term in solar energy estimates and is included in the NCDC AVHRR PATMOS-x delivery.
- PATMOS-x cloud data used by solar energy companies to drive short-term solar energy forecasts.



climatological mean cloud_transmission

0.40 0.52 0.64 0.76 0.88 1.00

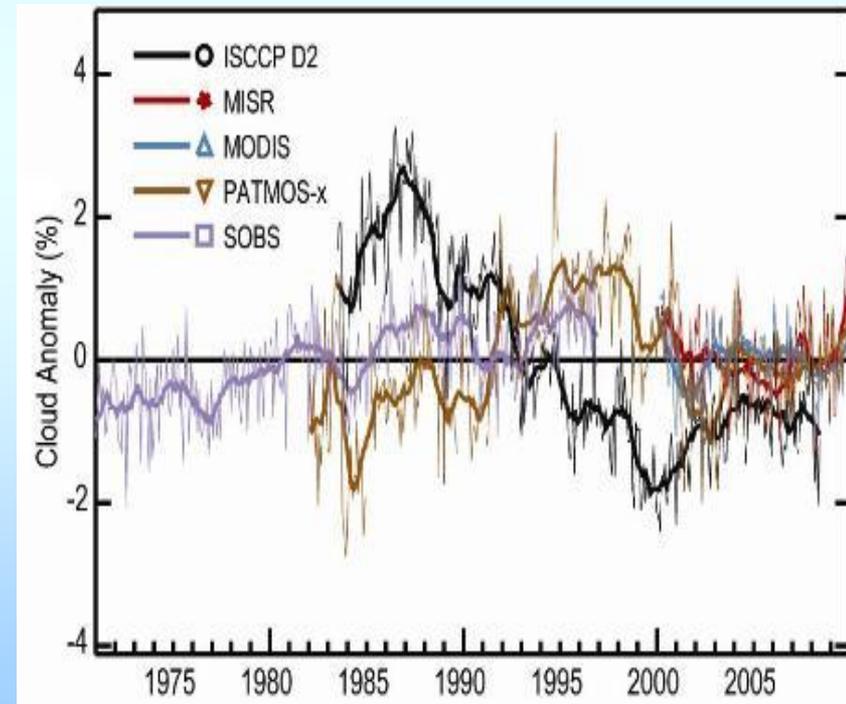
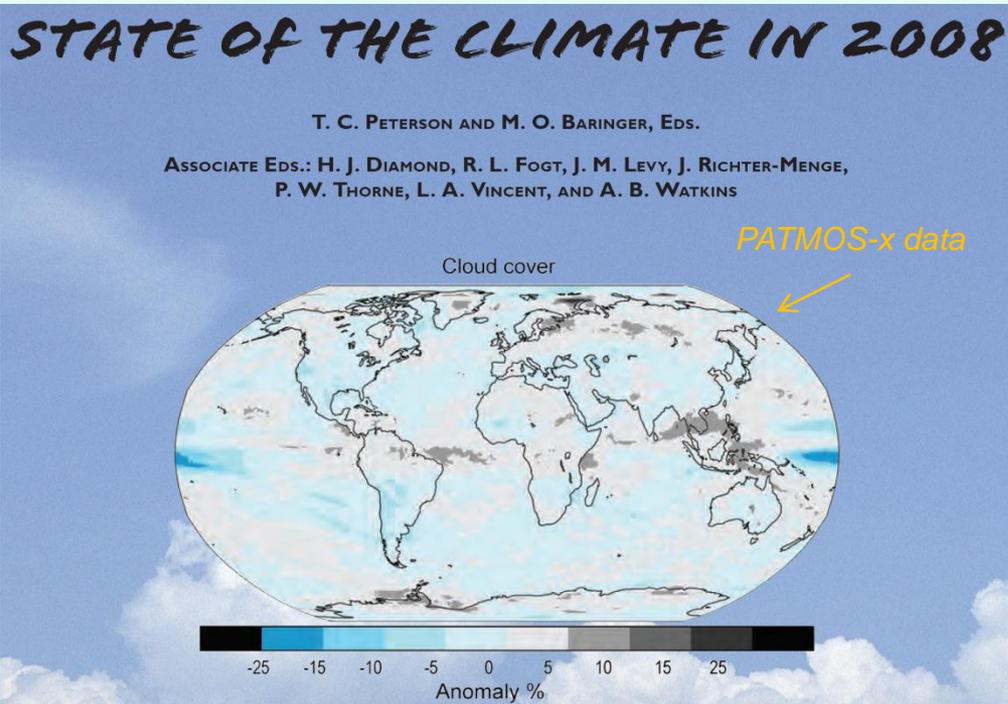


2012 - climatological mean cloud_transmission

-0.20 -0.10 0.00 0.10 0.20

Climate Studies

- PATMOS-x AVHRR data has appeared as the cloud data set using in BAMS State of Climate since 2006. Due to processing delays, ISCCP could not provide the short-term analysis needed for these reports.
- PATMOS-x is also submitted to the GEWEX Cloud Assessment and will be served alongside other satellite-based data sets in a standardized format.



Specific Non-academic Applications

- PATMOS-x data used in AMSU FCDR work (Huan Meng, NOAA/NESDIS)
- PATMOS-x FCDRs used for NOAA Aerosol CDR derivation (Tom Zhao, NCDC)
- PATMOS-x cloud amounts used for telescope siting study (Michael Prouza, Czech Republic)
- PATMOS-x cloud amounts used for Samoan Region coral bleaching study (NOAA)
- PATMOS-x FCDR data and methodology provided to EUMETSAT for use in CM-SAF cloud and surface reflectance products.
- PATMOS-x (GOES) serves cloud information to solar energy companies looking to make short-term forecasts of solar energy availability (30 min – 2 hour).
- PATMOS-x products served in TORERO and DC-3 field missions.

Schedule & Issues

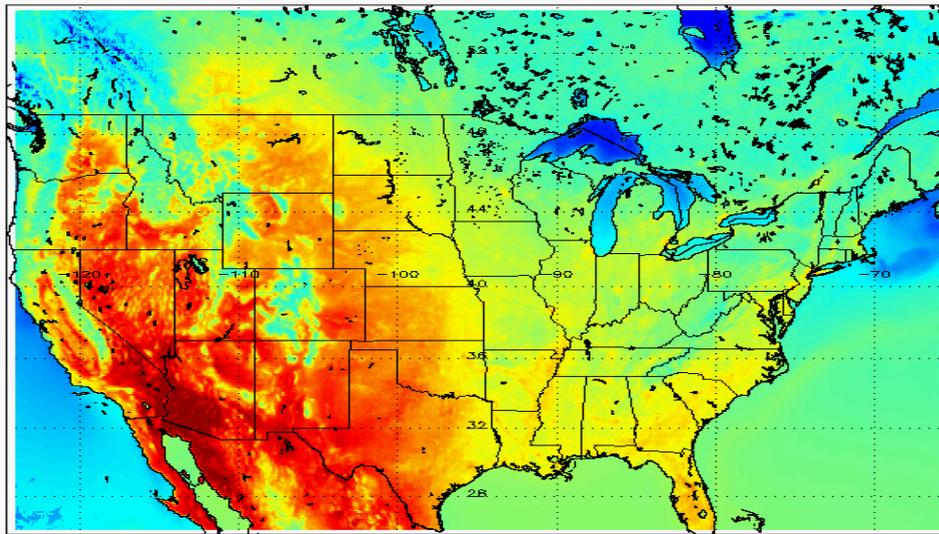
- State project status and plans for next phase of the project
 - Daily updates will commence later this summer.
 - Implementation documents due in August.
- State any risks or concerns
 - Daily updates are generated using extrapolated calibration. How are these data replaced by data covered by calibration updates months after the daily update?
 - PATMOS-x FCDRs are tied to MODIS. A new version of MODIS data is available soon that corrects some known recent calibration issues. How do we redeliver?
 - If we redeliver, some users have suggested changes in the data format (shifting the grid and selecting pixels randomly opposed to nearest neighbor sampling).
- Some suggestions for the PATMOS-x data interface.
 - Would be nice to order products independent of sensor. (Say cloud amount for a given time and space window - not the NOAA-7 product and the NOAA-9 product separately).
 - Add visualization of the PATMOS-x data.
 - More products need to be included to make the data useable.

Thanks!

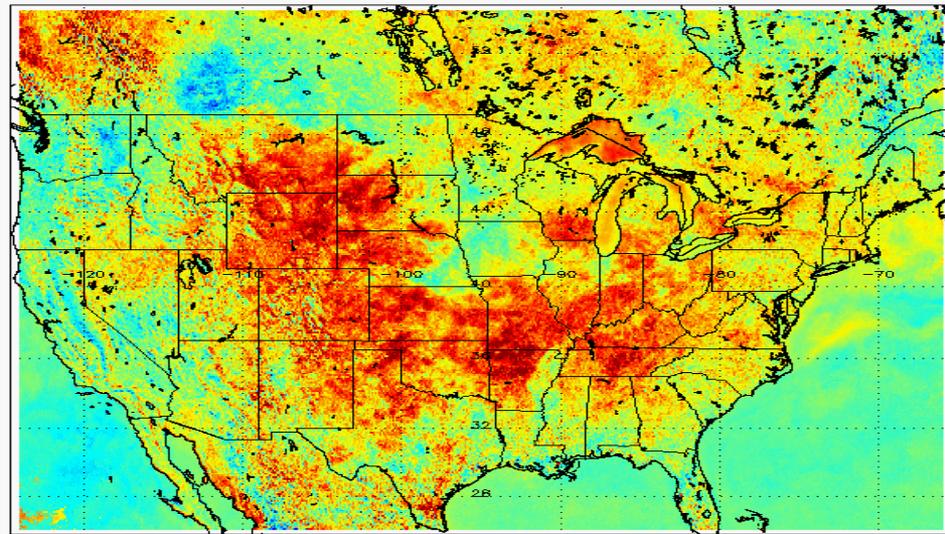


Surface Temperature

- Surface temperature can be estimated from PATMOS-x.
- Images below show the relatively warm July 2012 compared to the AVHRR record as whole.



climatological mean surface_temperature_retrieved
270.00 282.00 294.00 306.00 318.00 330.00



2012 - climatological mean surface_temperature_retrieved
-10.00 -5.00 0.00 5.00 10.00