In-Flight Validation of Mid and Thermal Infrared Remotely Sensed Data from MODIS (Terra and Aqua) Using the Lake Tahoe and Salton Sea Automated Validation Sites

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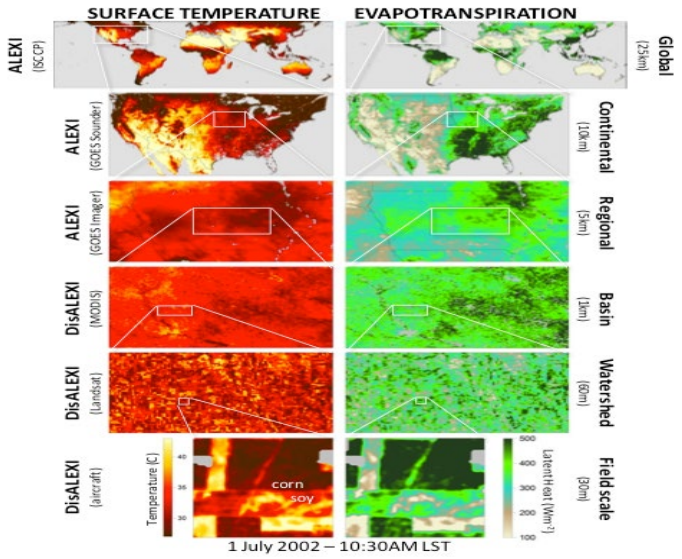
Outline

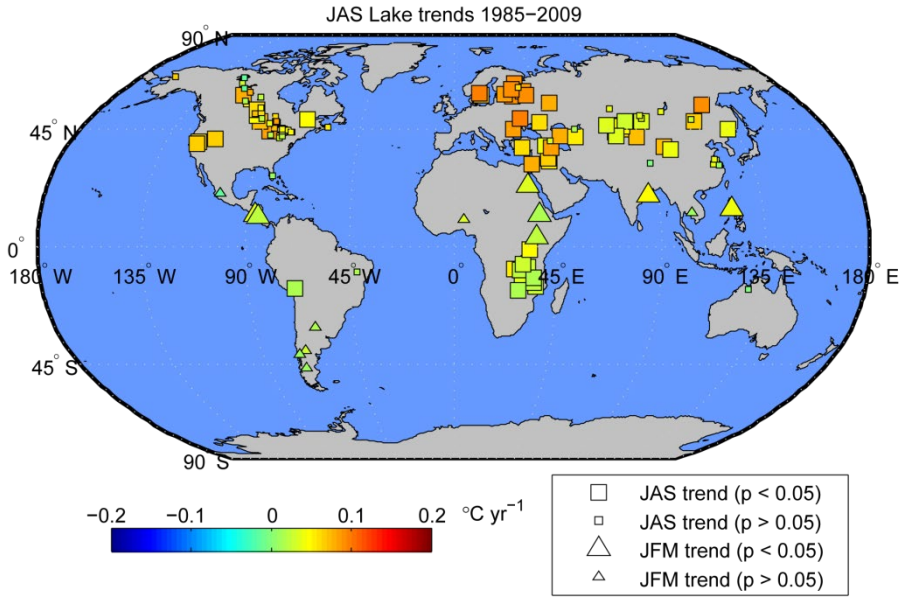
- Introduction
- Location
- Measurements and Calibration
- Data Reduction Methodology
- Results from various sensors
  - TIR MODIS and a little VIIRS
  - MIR MODIS
- Summary and Conclusions

Earth Science Use of LST&E

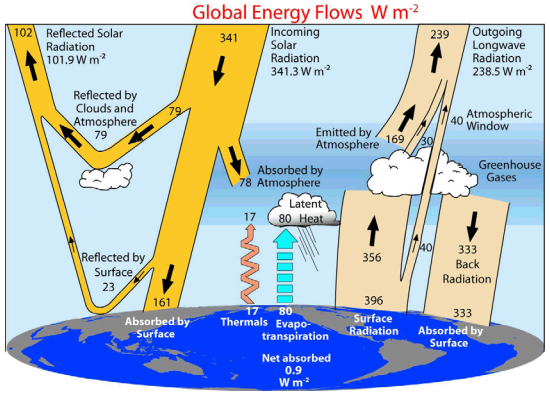
Evapotranspiration (drought monitoring)



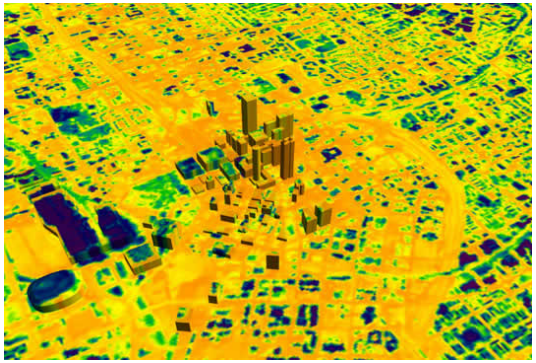
Understanding Climate Change



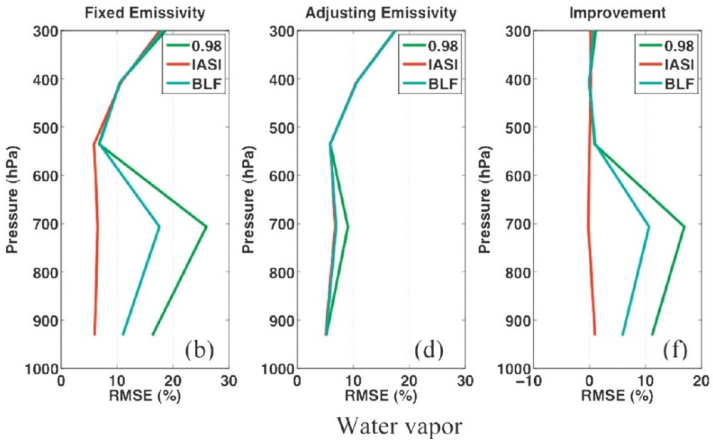
Surface Energy Balance



Urban Heat Island Studies

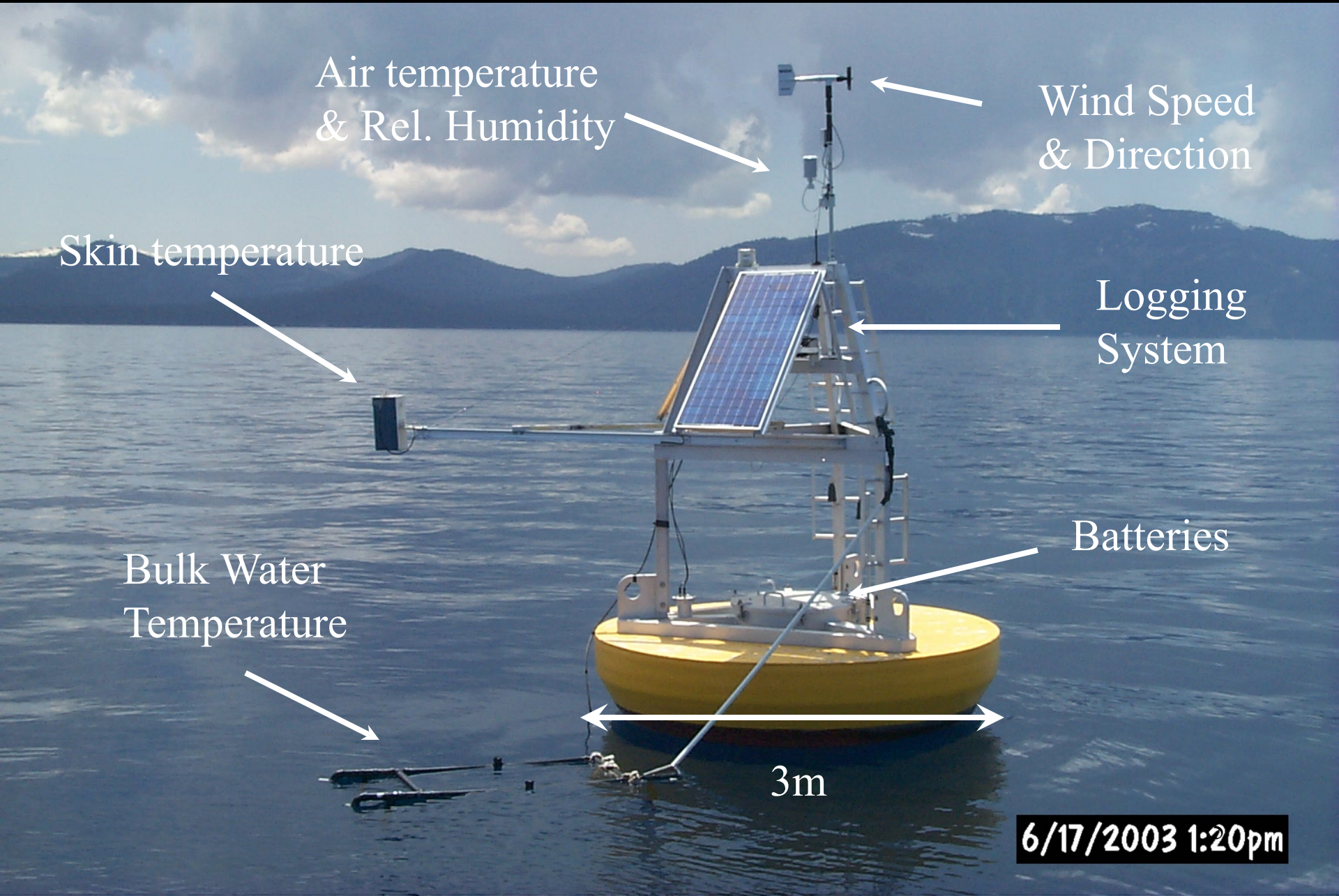


Atmospheric profile retrievals



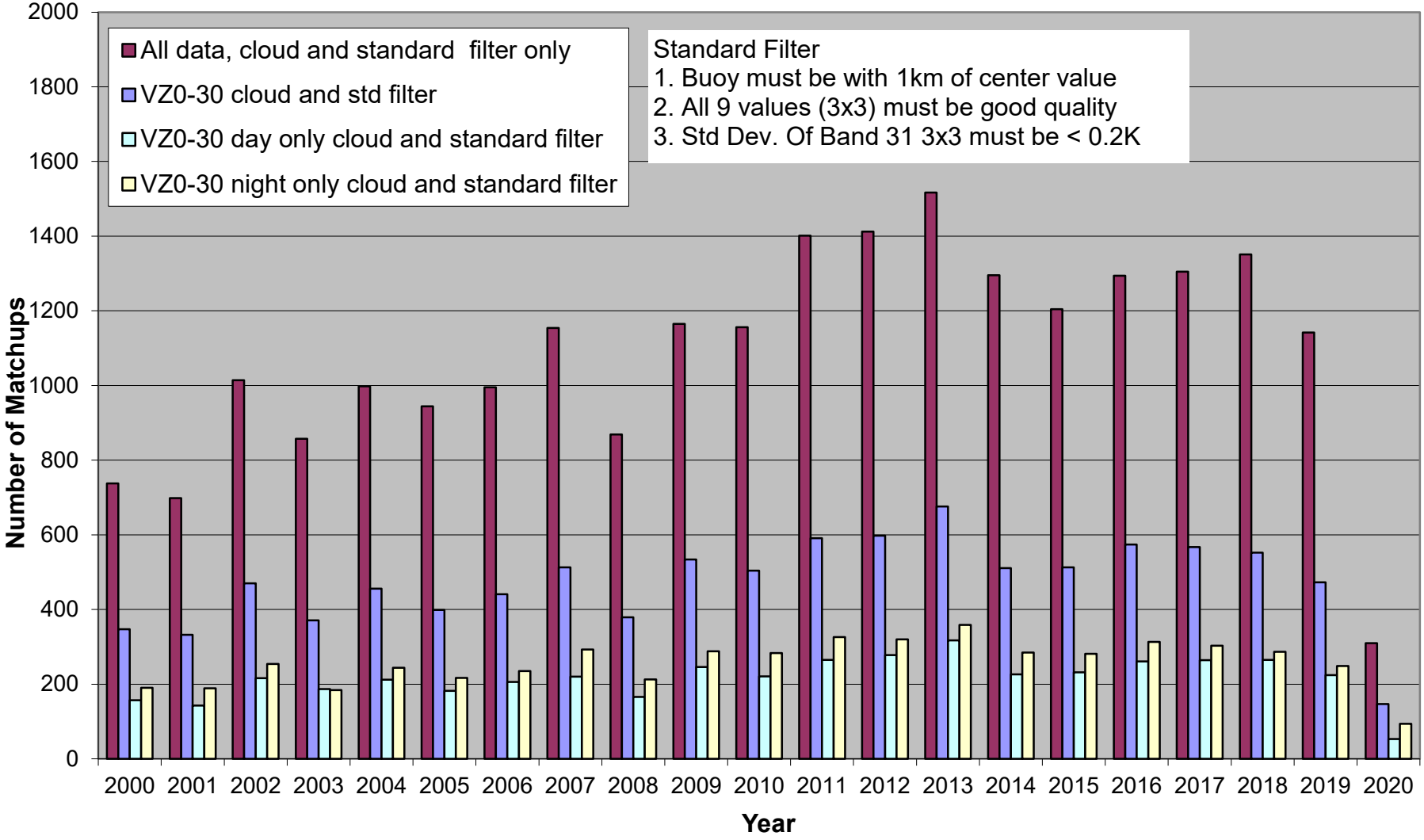
- Large 35 km x 16 km
- High 2 km
- Available year round (does not freeze in winter).
- Homogenous compared with land.
- Large annual temperature range 5-25 C.
- Freshwater (kind to instruments!)
- Good infrastructure and easy access.

TB3 Installed 11-04-2002

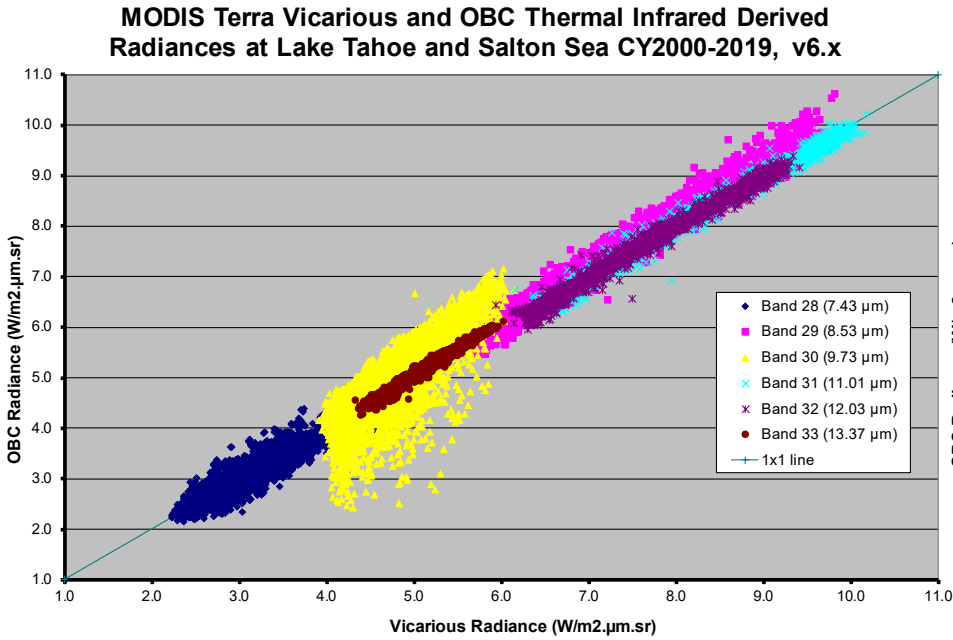


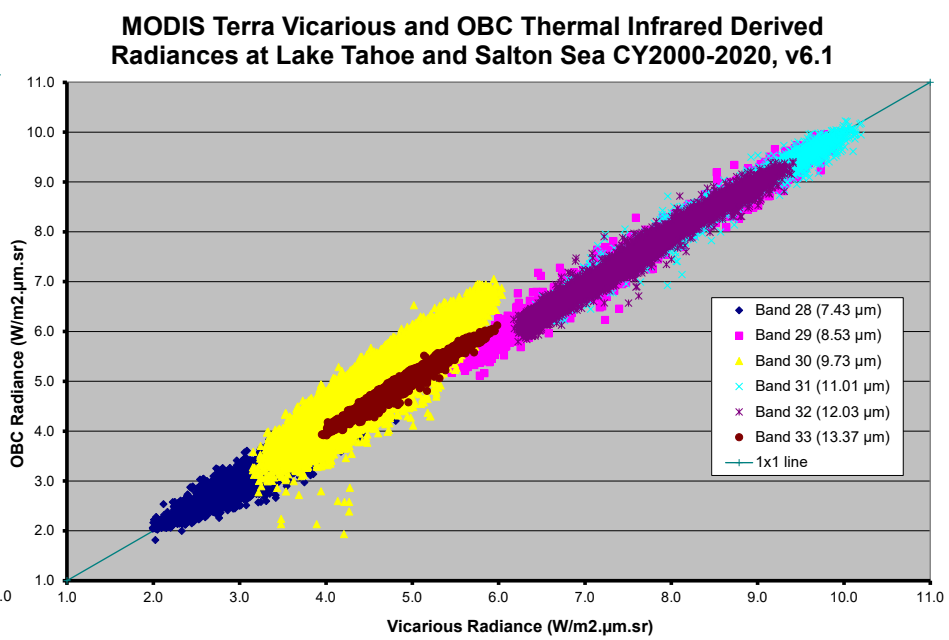
Custom-Built Radiometers Calibrated to NIST Traceable Blackbody

Matchup Count for MODIS Terra at Lake Tahoe and Salton Sea CY2000-2020 v6.1

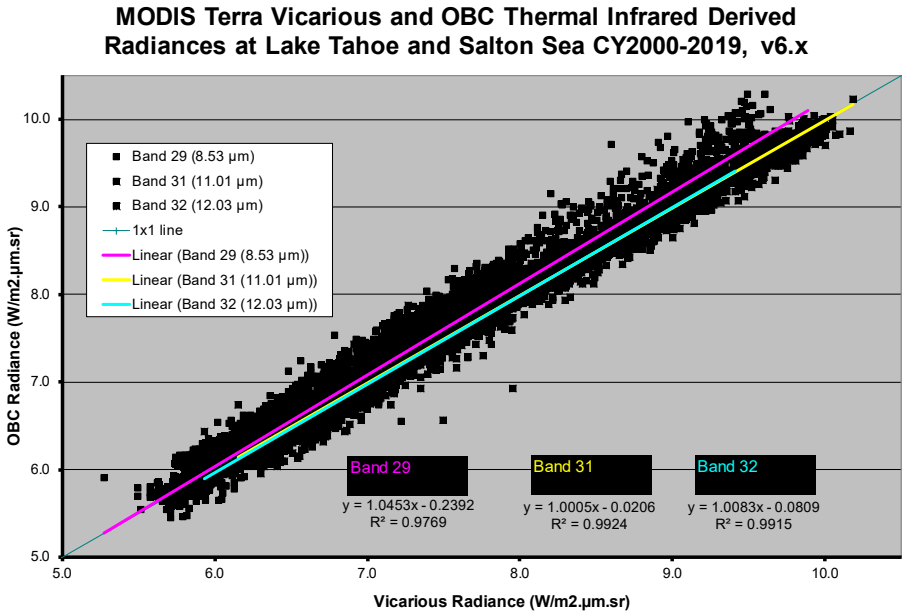


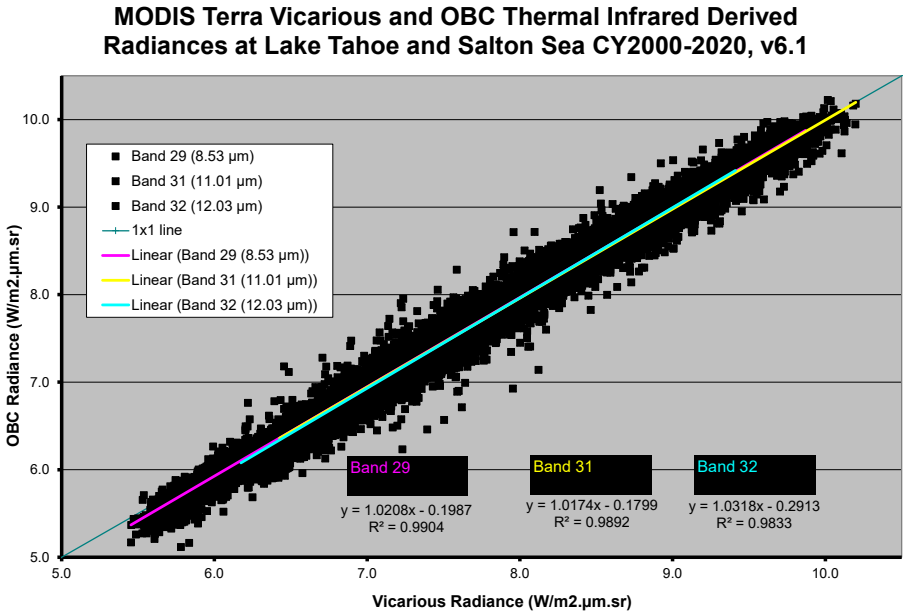
Now have large numbers of matchups – can restrict to optimum view angles



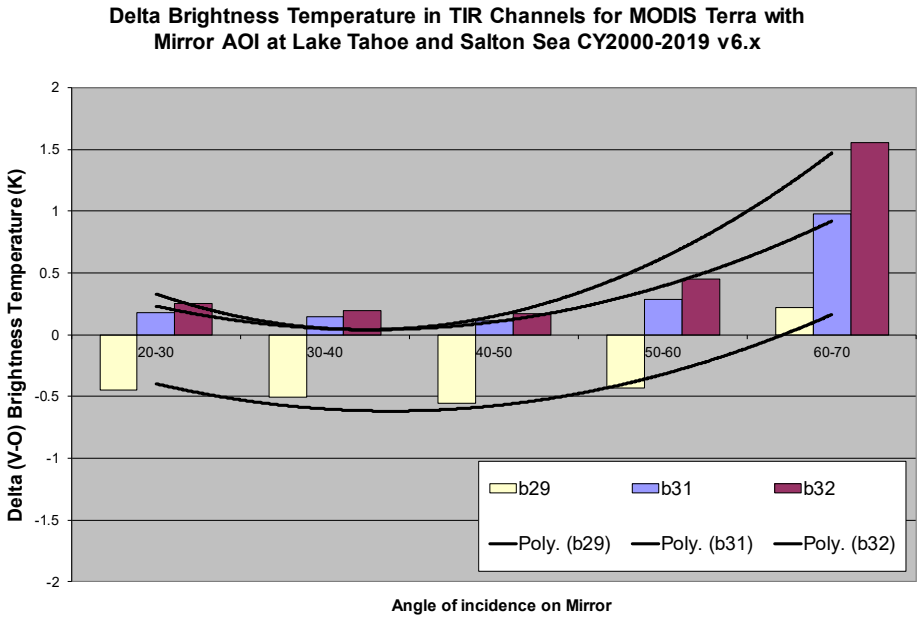


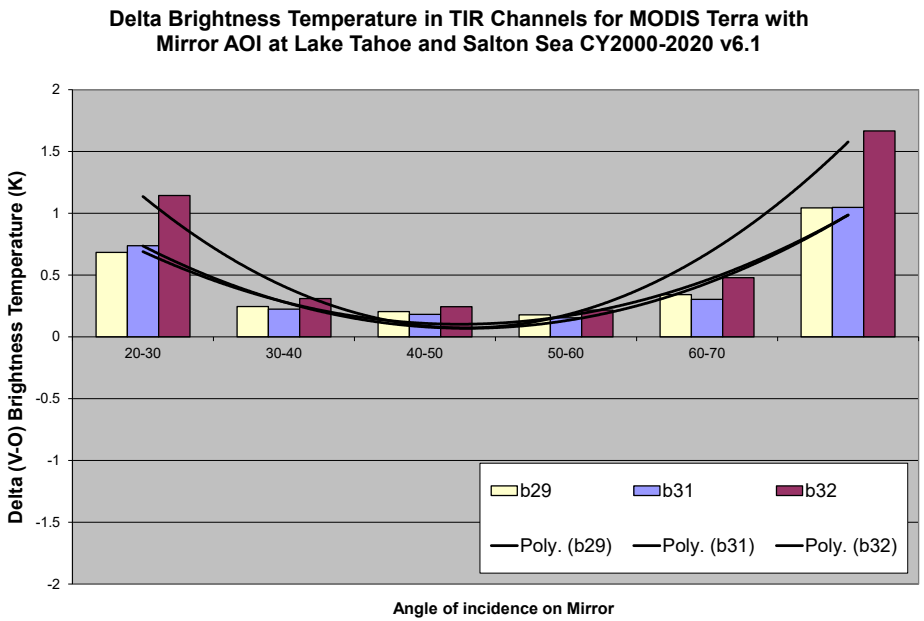
IR Window bands 31 and 32 align nicely with 1x1 line, but Band 29 does not.



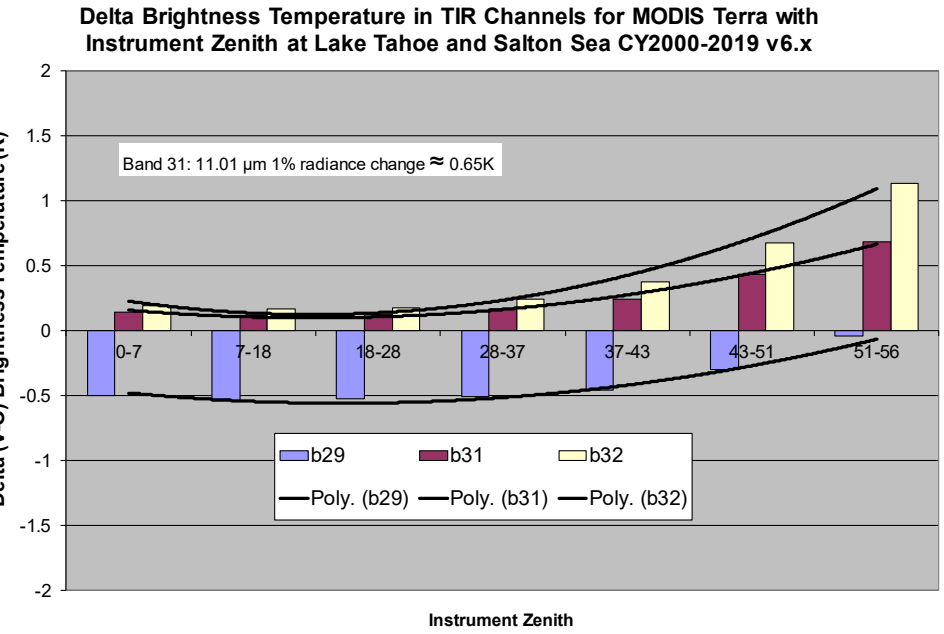


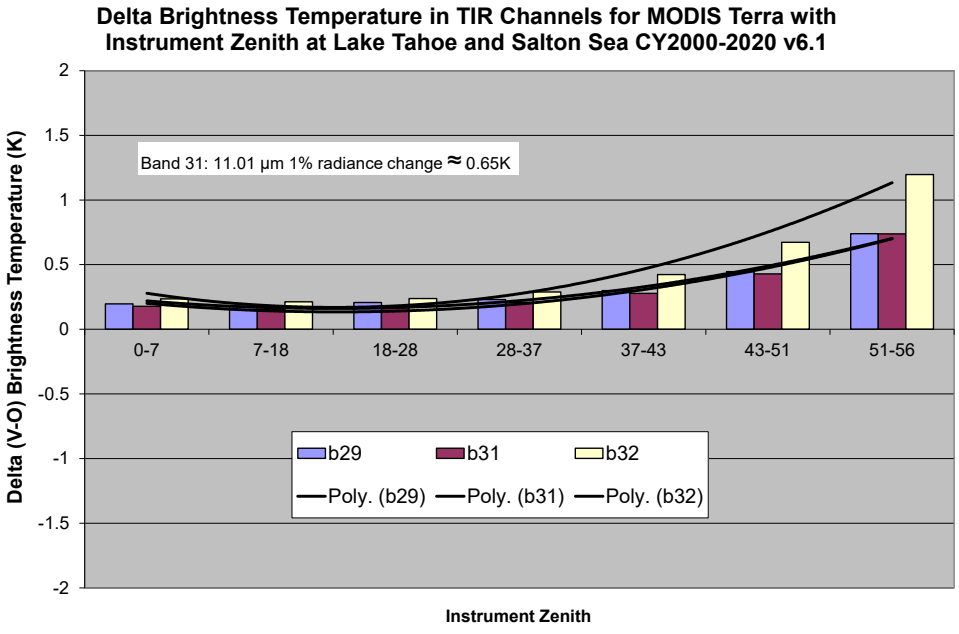
Window bands 31 and 32 closely follow 1 to 1 line, but 29 is out of family



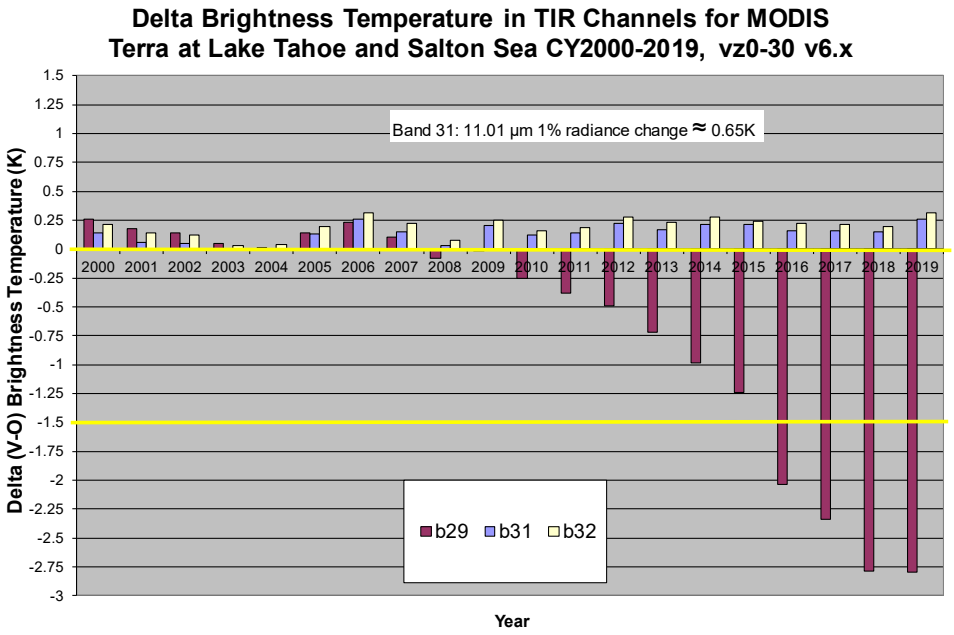


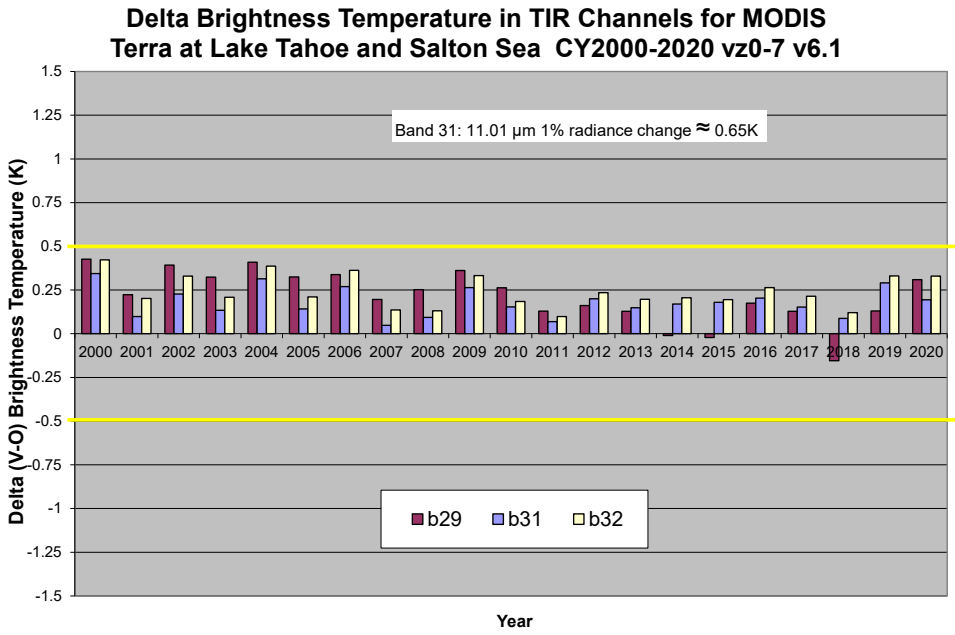
AOI relates to viewing geometry, more oblique views worse validation as expected



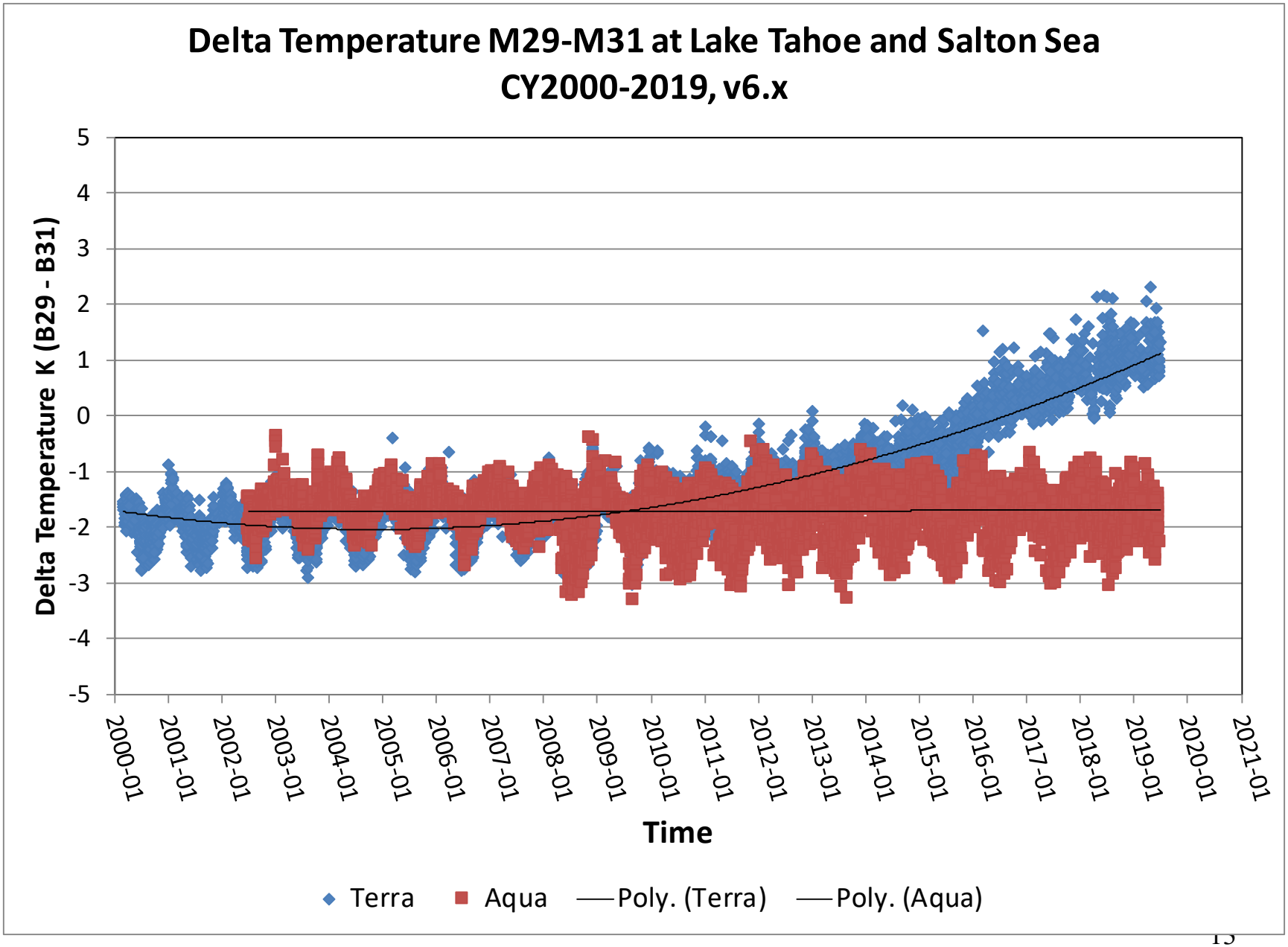


Analysis indicate get excellent results with in situ out to about 30 degrees but problem with calibration of b29

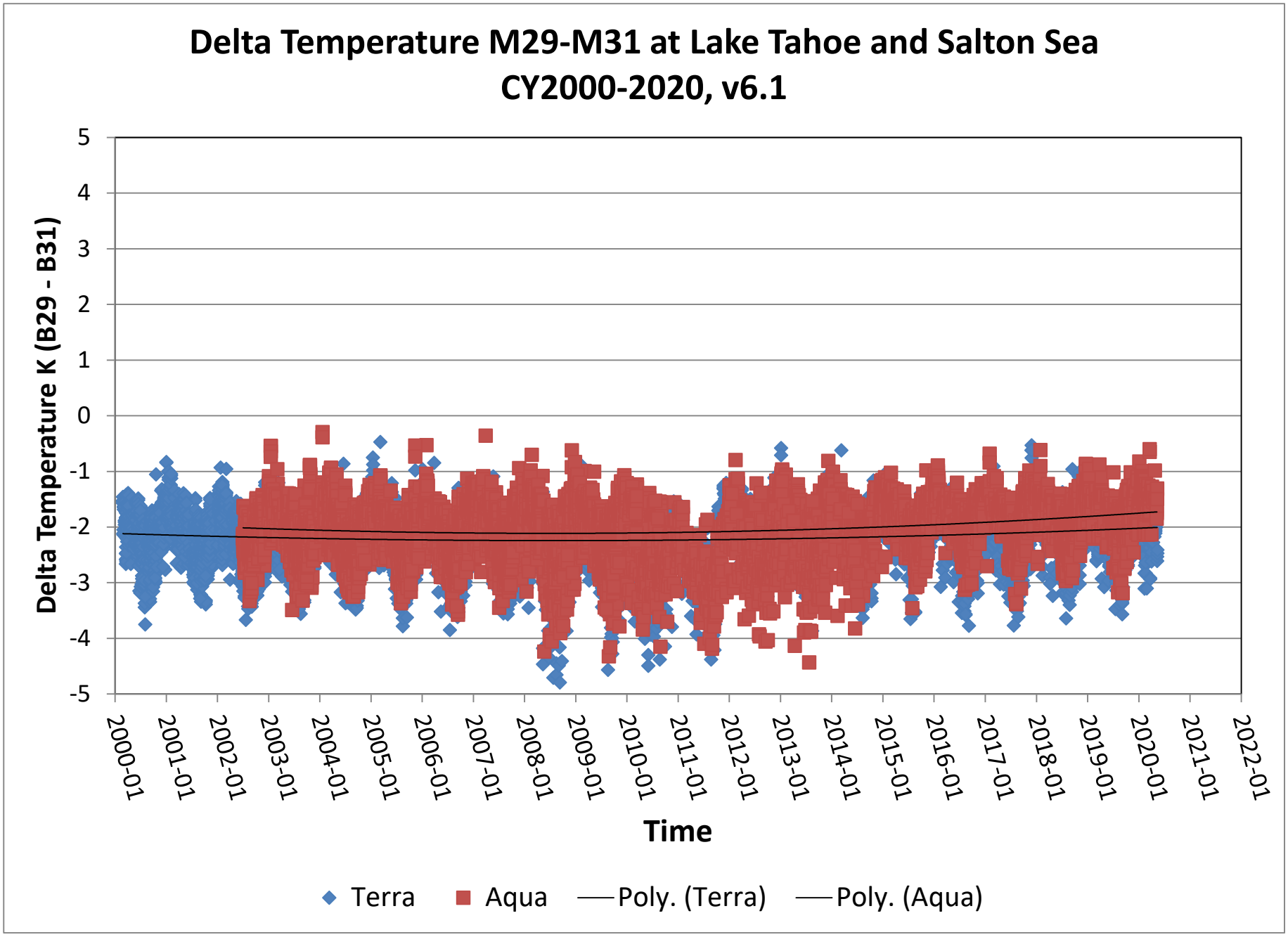


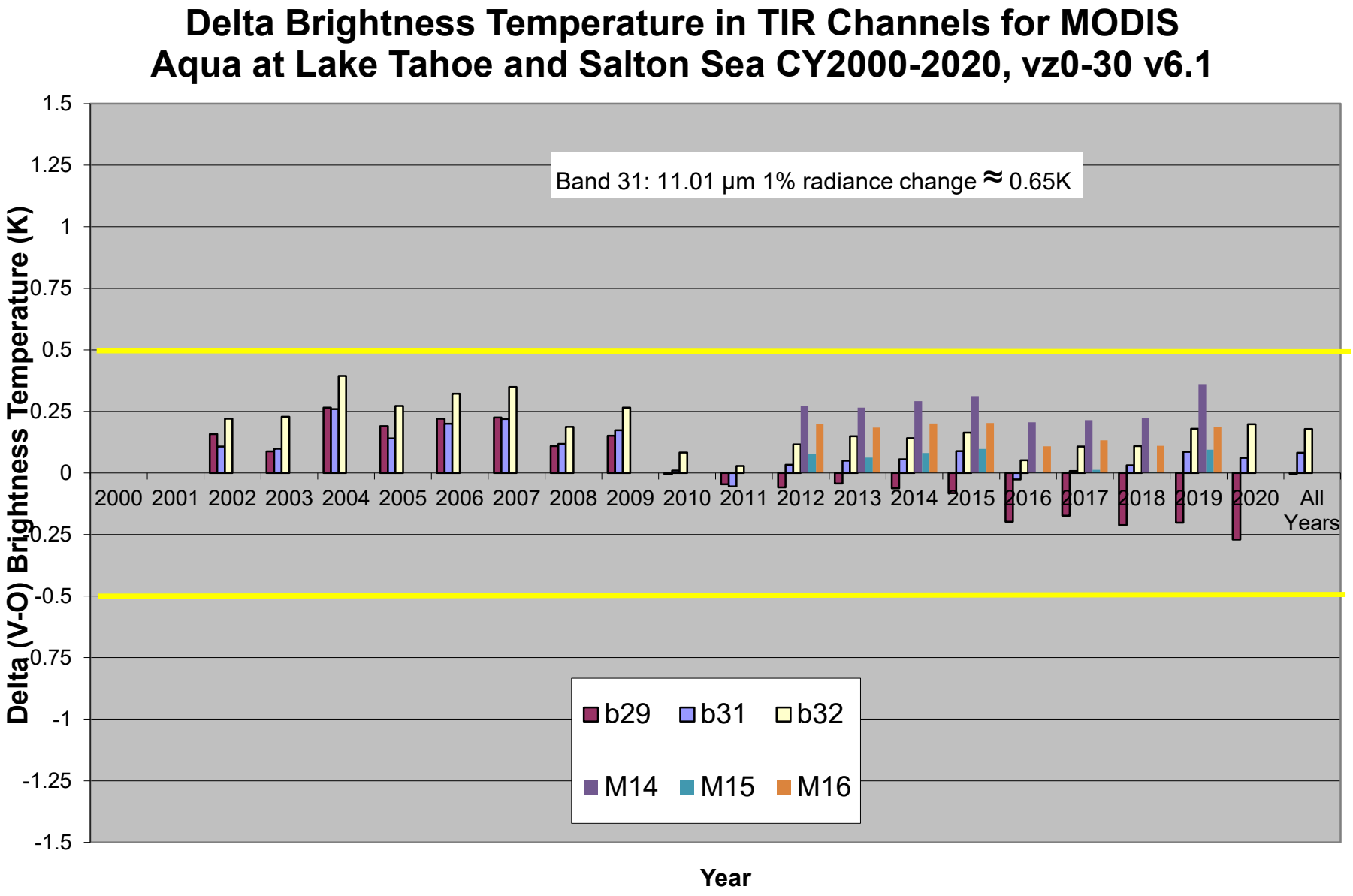


Excellent calibration until 2009. Since 2009 channel 29 calibration has degraded



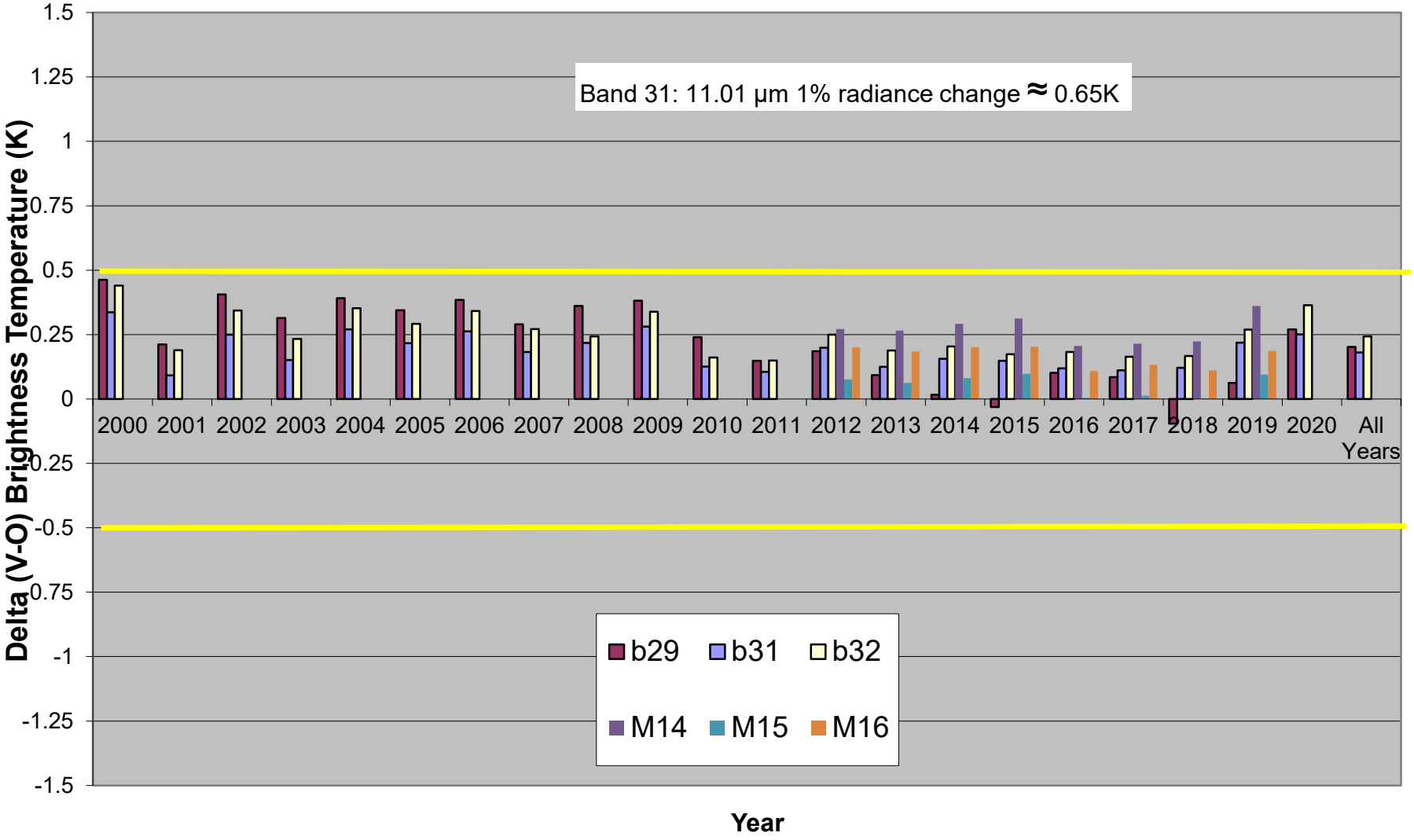
Similar analysis to previous slides but notice how range of Aqua data has increased

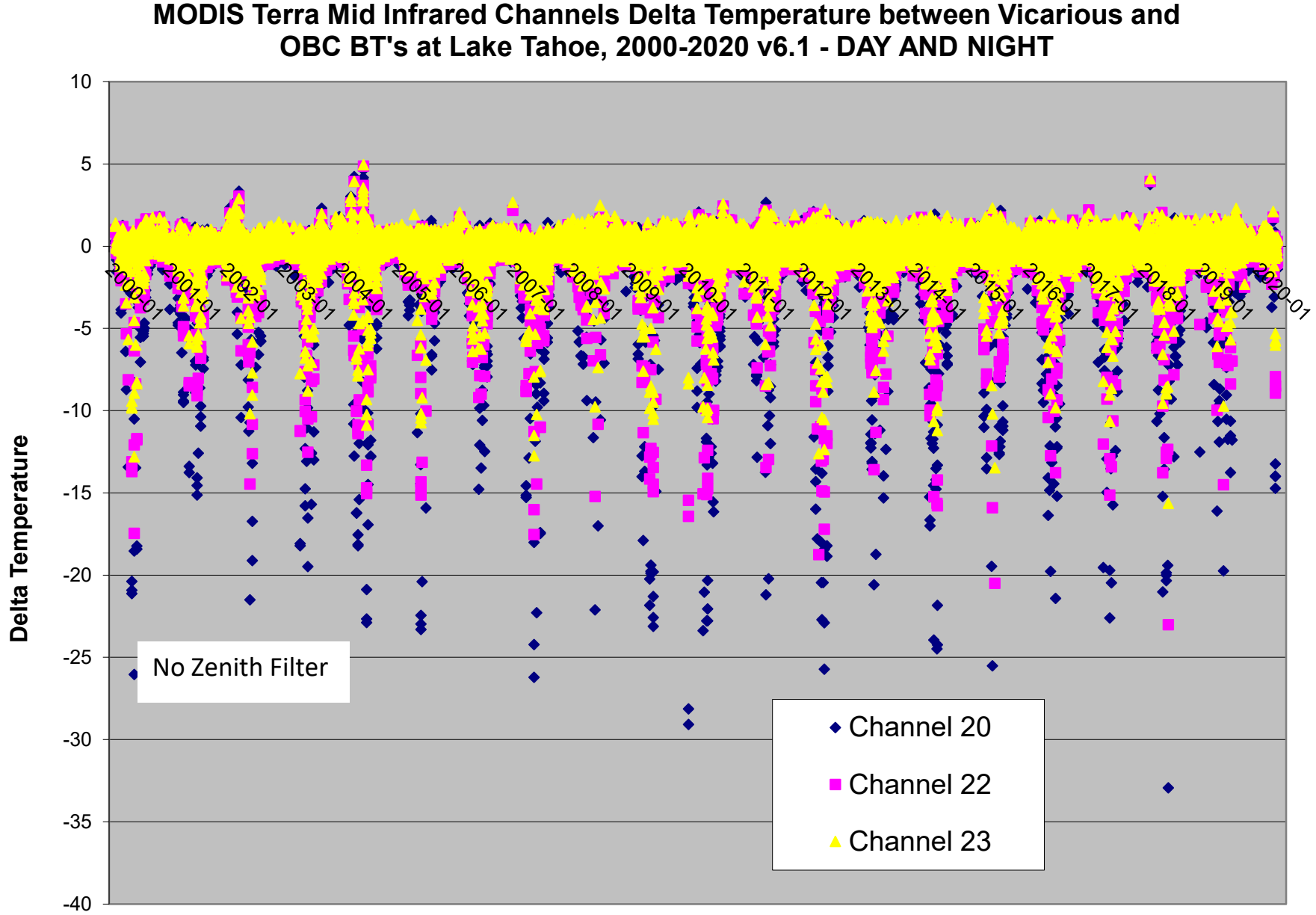

Delta Temperature M29-M31 at Lake Tahoe and Salton Sea
CY2000-2020, v6.1
Delta Temperature K (B29 - B31)
5
4
3
2
1
0
-1
-2
-3
-4
-5
2000-01
2001-01
2002-01
2003-01
2004-01
2005-01
2006-01
2007-01
2008-01
2009-01
2010-01
2011-01
2012-01
2013-01
2014-01
2015-01
2016-01
2017-01
2018-01
2019-01
2020-01
2021-01
2022-01
Time
Terra
Aqua
Poly. (Terra)
Poly. (Aqua)



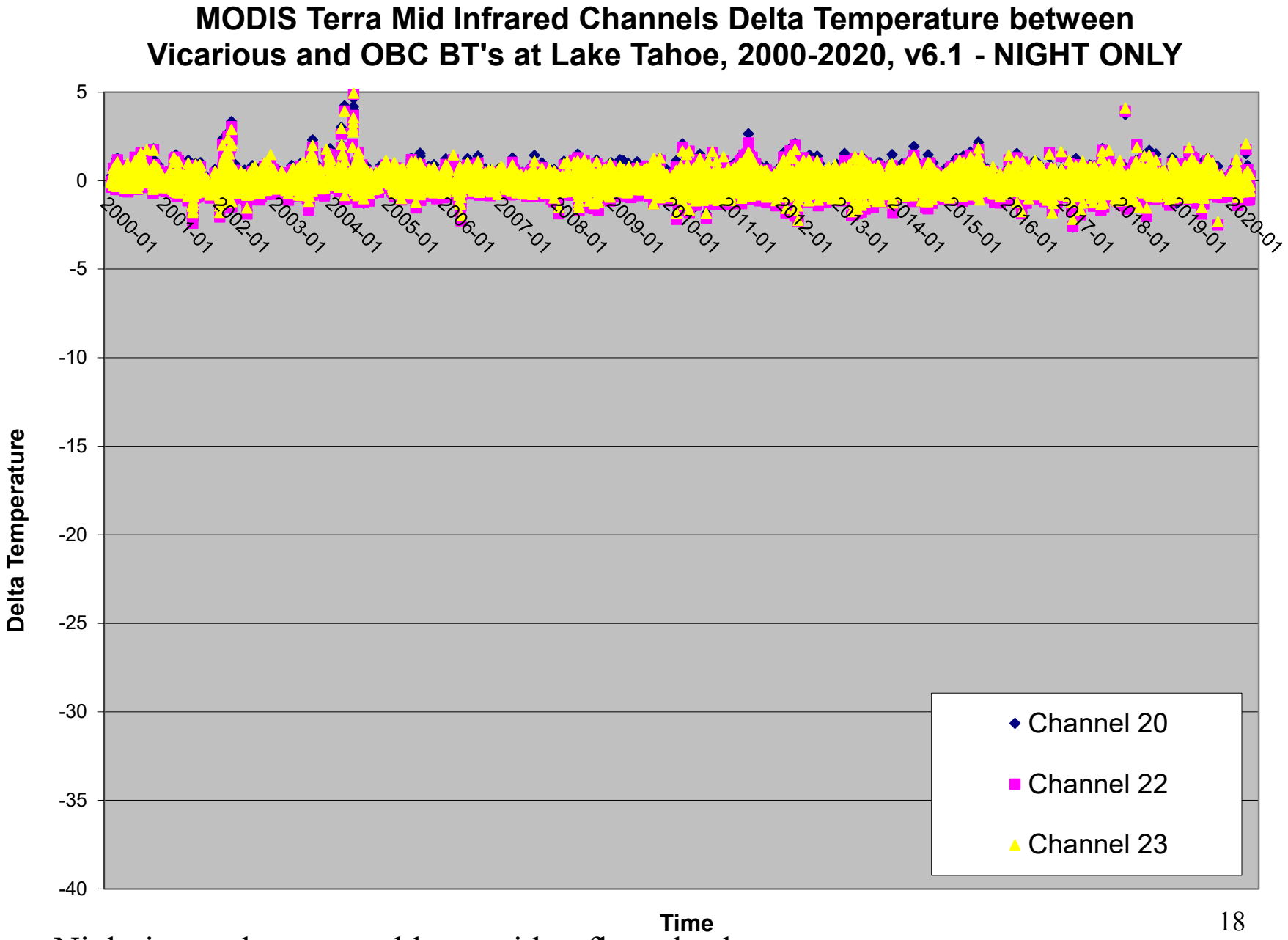
No sign of problems in channel 29 on Aqua-MODIS, VIIRS performance similar to MODIS

Delta Brightness Temperature in TIR Channels for MODIS Terra at Lake Tahoe and Salton Sea CY2000-2020, vz0-30 v6.1



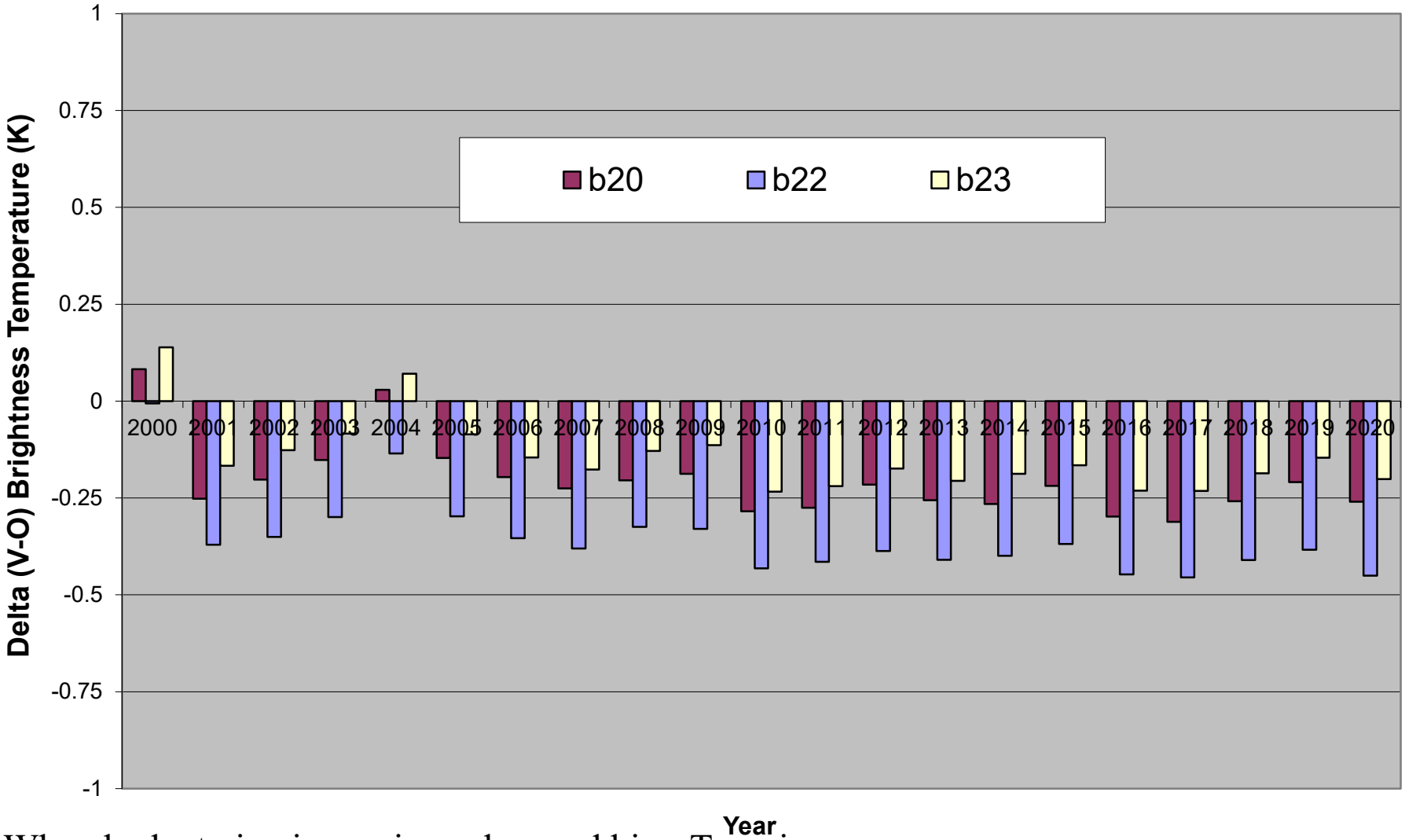


Can also use buoy data to validate MIR channels but cannot use daytime values since affected by reflected solar (as illustrated above). Since buoys operate 24x7 use just nighttime data (see next slide)

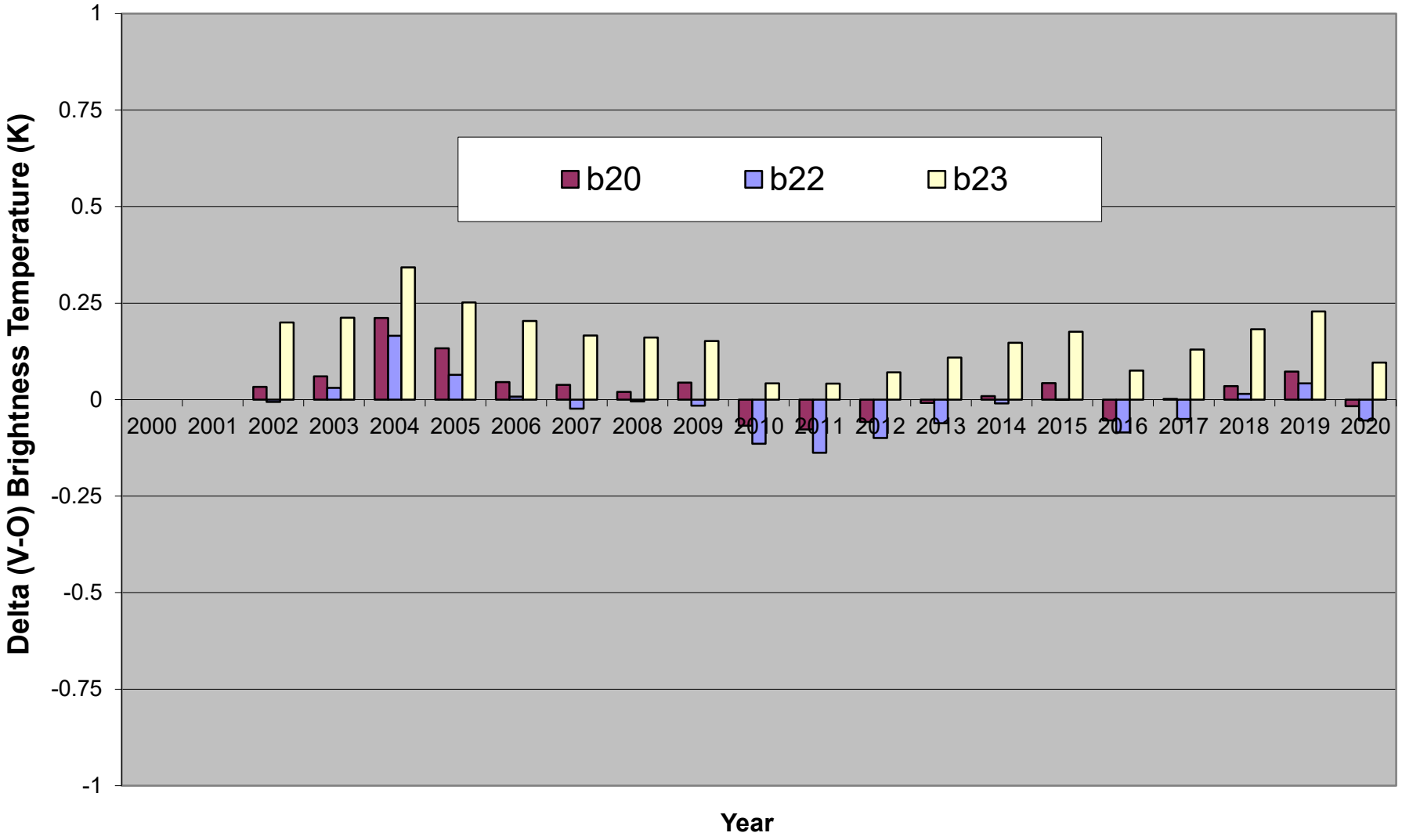


Nighttime only – no problems with reflected solar

Delta Brightness Temperature in MIR Bands for MODIS Terra at Lake Tahoe and Salton Sea CY2000-2020, vz0-30, v6.1



When look at vicarious minus observed bias, Terra is warm.



No bias in MIR channels of Aqua

Summary and Conclusions

- Established an automated site for validating thermal infrared data at Lake Tahoe CA/NV. Site has been operating since 1999.
- Measurements made at the site include skin- bulk- air- temperature, wind speed, wind direction and net radiation at multiple locations every 2 minutes. Multiple locations (4 buoys) allow validation of several points within a scene.
- Second site added at Salton Sea in 2008 to enable validation at high water temperatures (~35 C).
- Validated data from multiple instruments including, AATSR, ASTER, ECOSTRESS, MODIS (Terra, Aqua), VIIRS, Landsat 5, 7, 8 and MTI.
- Results so far indicate
  - MODIS-Terra at-sensor radiance: TIR 29,31, 32, no bias, abs. acc. ± 0.25K
  - MODIS-Aqua at-sensor radiance: TIR, 31, 32 no bias, abs. acc. ± 0.25K
  - MODIS-Terra at-sensor radiance: TIR 29, small bias, abs. acc. ± 0.25K
  - MODIS-Terra at-sensor radiance: MIR, bias 0.24 K
  - MODIS-Aqua at-sensor radiance: MIR, bias 0.10 K