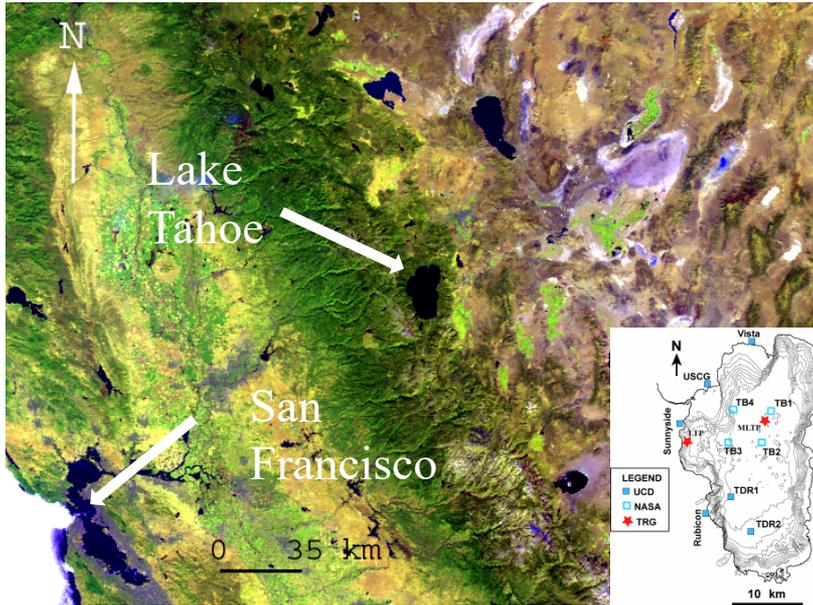


# In Flight Validation of MODIS and VIIRS Mid and Thermal Infrared Emissive Bands at Lake Tahoe and Salton Sea CA/NV USA

Simon J. Hook, Kerry Cawse-Nicholson, Robert  
Radocinski, Glynn C. Hulley

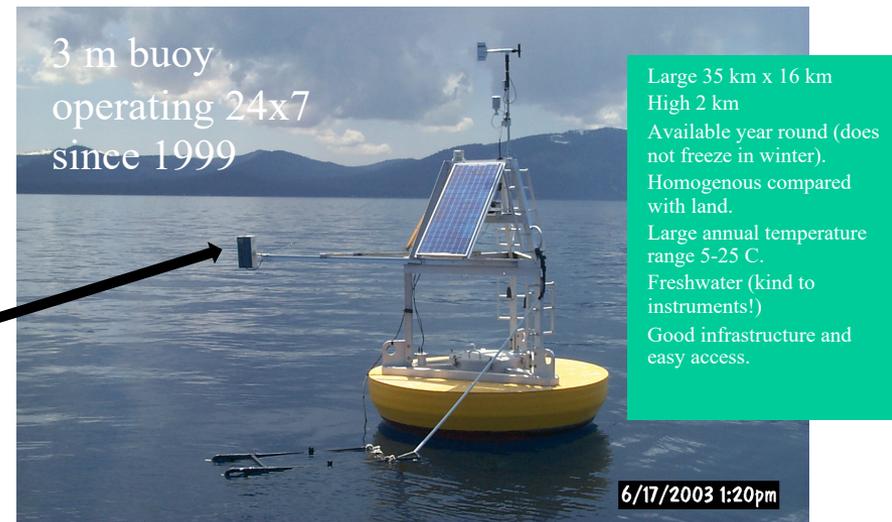
# Vicarious at Lake Tahoe, CA/NV USA



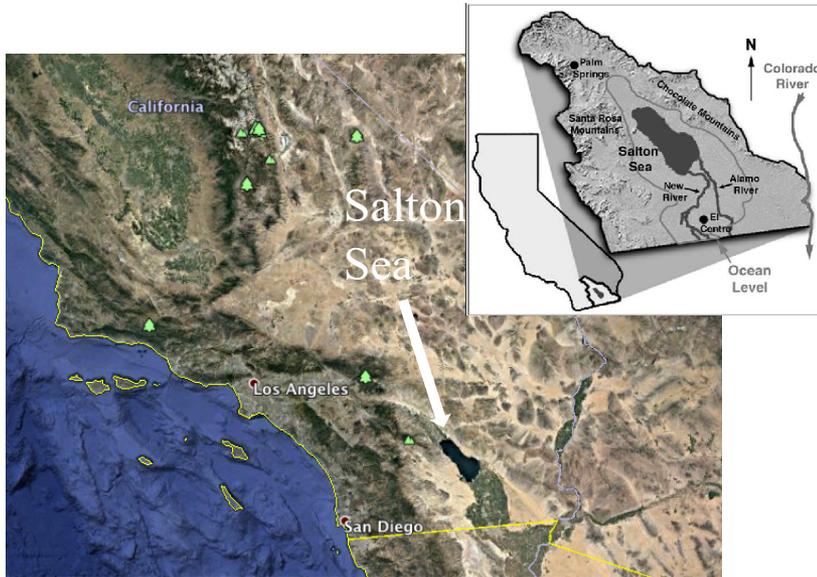
## Methodology:

- 4 buoys on large, high lake, each buoy is 1 km from shore and nearest buoy.
- Each buoy has custom thermal infrared radiometer operating 24x7 and associated meteorological measurements.
- Extract skin temperature from radiometer at time of overpass and propagate to top of atmosphere with radiative transfer model.
- Convolve to instrument system response functions and compare to satellite instrument measured value.

## Custom radiometer calibrated to NIST-traceable blackbody



# Vicarious at Salton Sea, CA USA



## Methodology:

- A mounted platform due to high salinity.
- The site has two custom thermal infrared radiometers operating 24x7 and associated meteorological measurements.
- Extract skin temperature from radiometer at time of overpass and propagate to top of atmosphere with radiative transfer model.
- Convolve to instrument system response functions and compare to satellite instrument measured value.

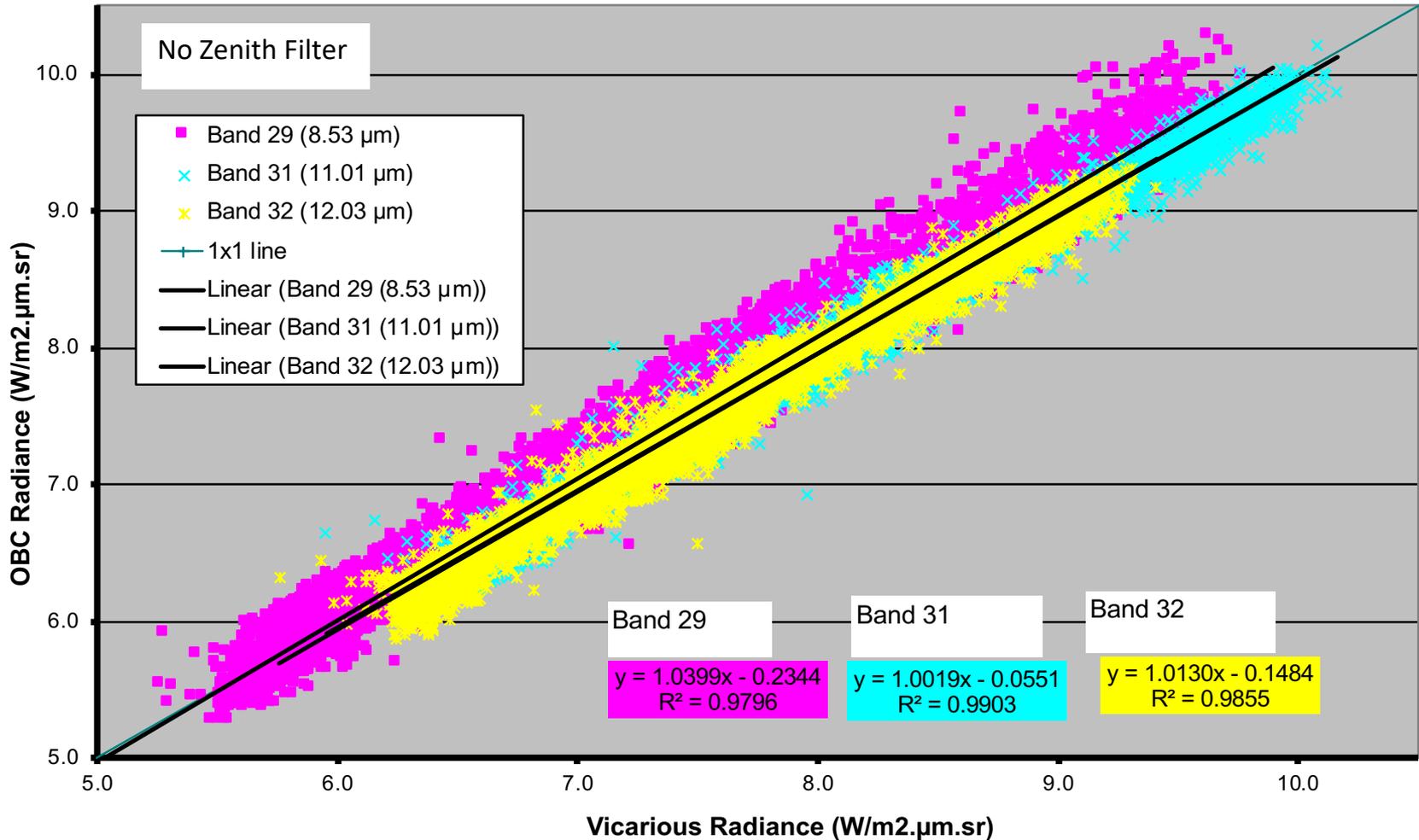
## Custom radiometer calibrated to NIST-traceable blackbody



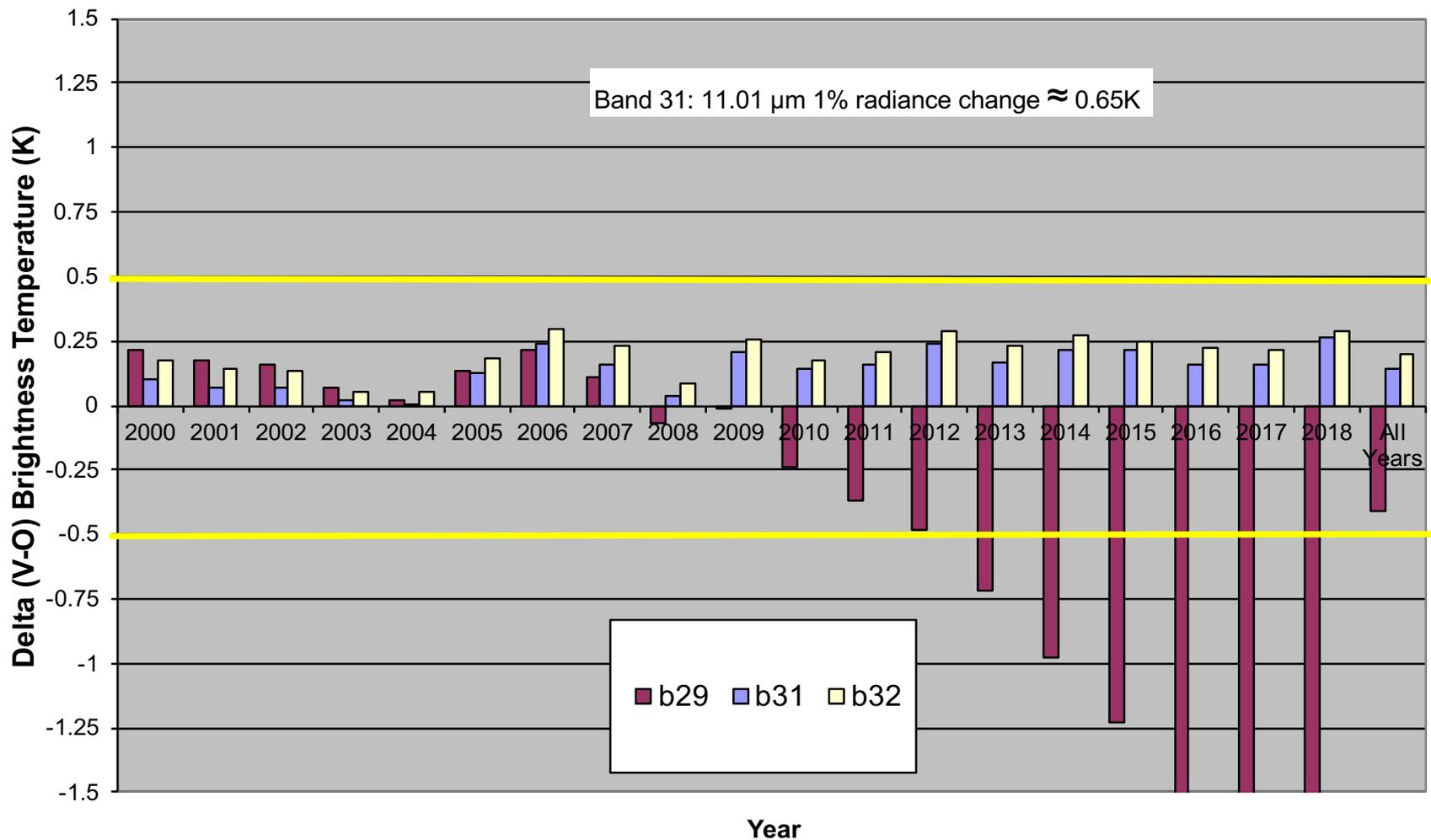
Large 60 km x 20 km  
Low elevation -71 m  
Available year round (does not freeze in winter).  
Homogenous compared with land.  
Large annual temperature range ~4-35 C.  
Good infrastructure and easy access.

# Terra-MODIS - Results

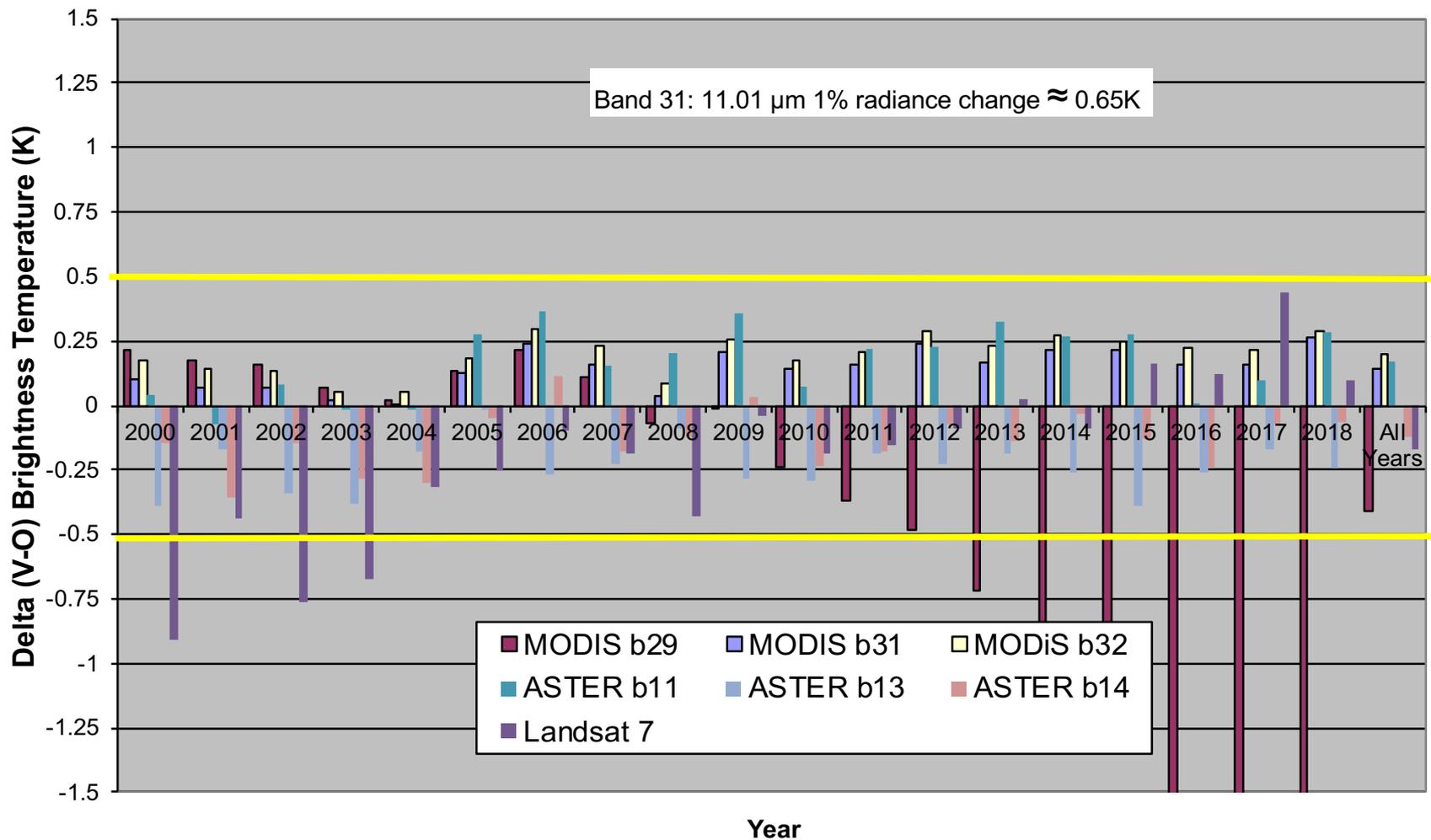
**MODIS Terra Vicarious and OBC Thermal Infrared Derived Radiances at Lake Tahoe and Salton Sea CY2000-2018, v5.x**



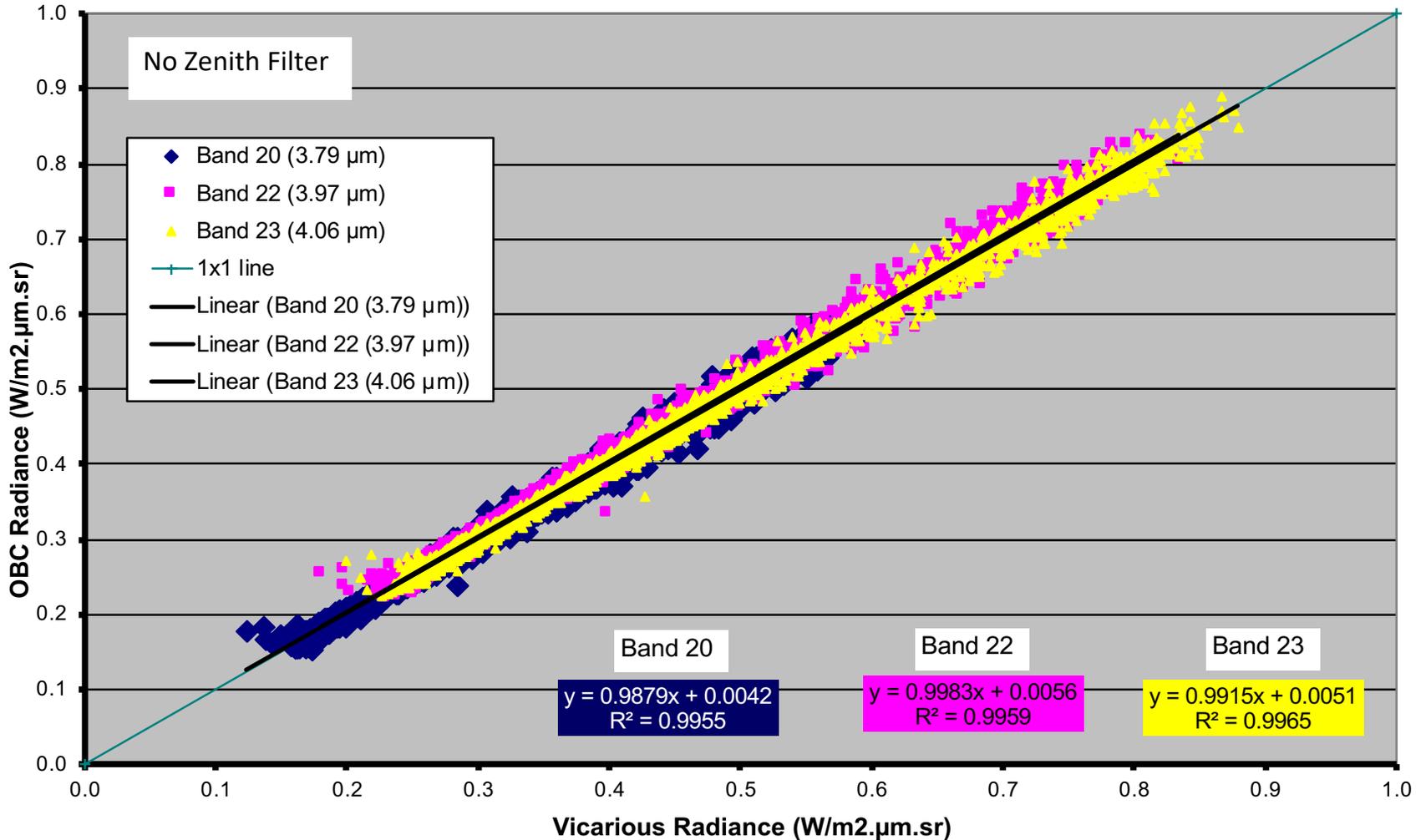
## Delta Brightness Temperature in TIR Channels for MODIS Terra at Lake Tahoe and Salton Sea CY2000-2018, vz0-30 v5.x



## Delta Brightness Temperature in TIR Channels for MODIS Terra at Lake Tahoe and Salton Sea CY2000-2018, vz0-30 v5.x

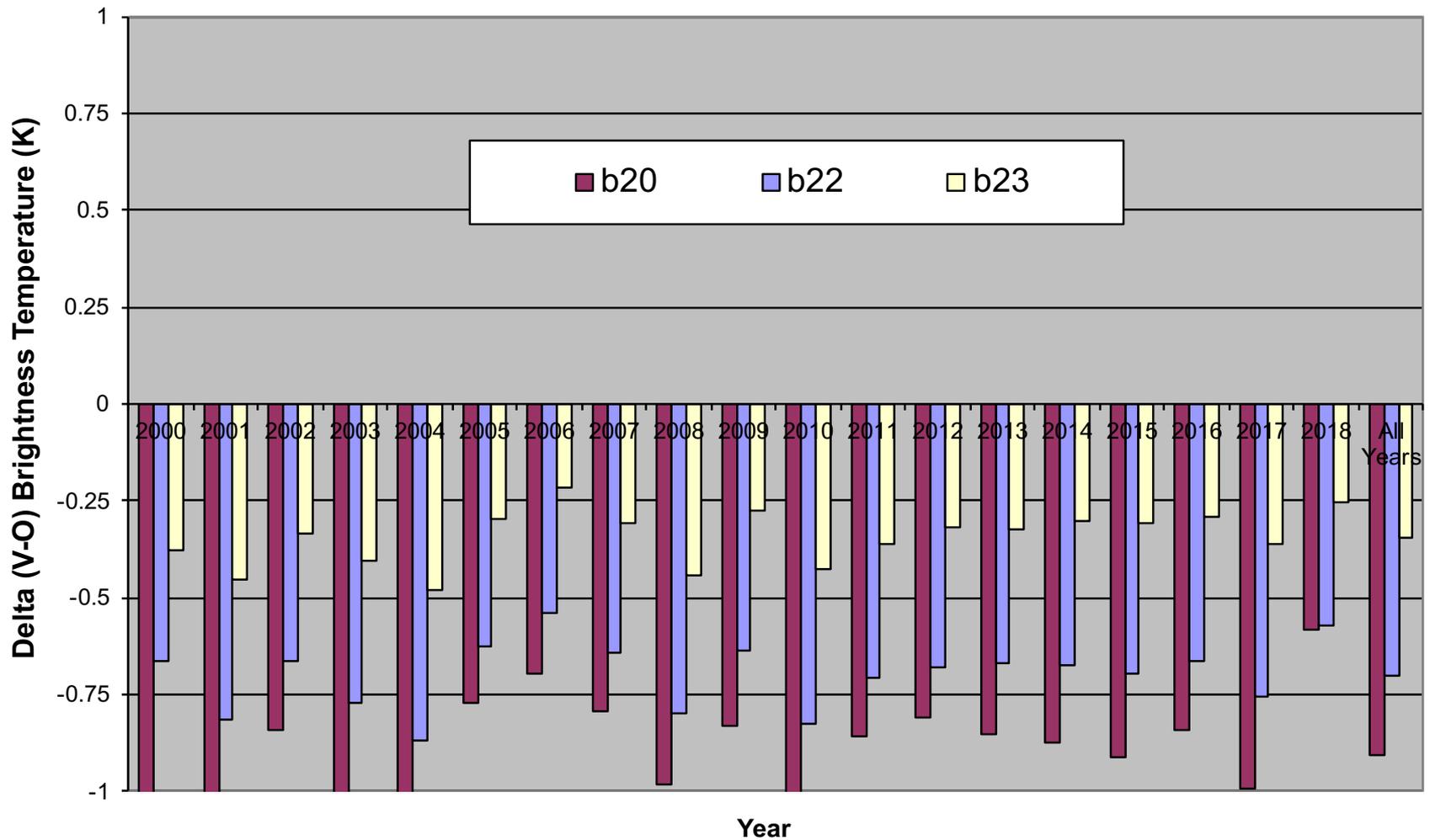


# MODIS Terra Night Only Vicarious and OBC Mid Infrared Derived Radiances at Lake Tahoe and Salton Sea CY2000-2018, v5.x



MODIS-Terra – MIR bands are consistently slightly hot.

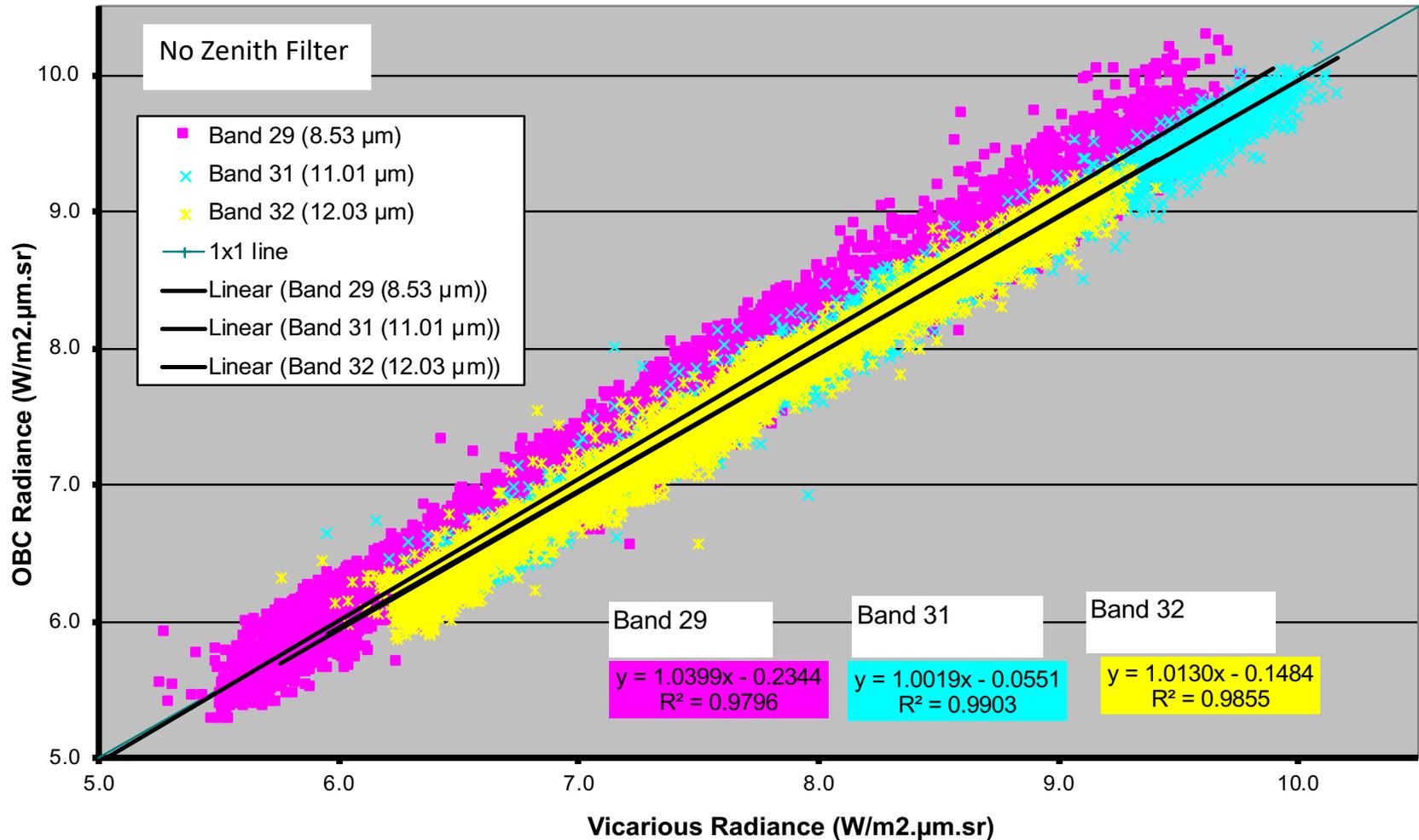
## Delta Brightness Temperature in MIR Bands for MODIS Terra at Lake Tahoe and Salton Sea CY2000-2018, vz0-30, v5.x



MODIS-Terra – MIR bands are consistently slightly hot.

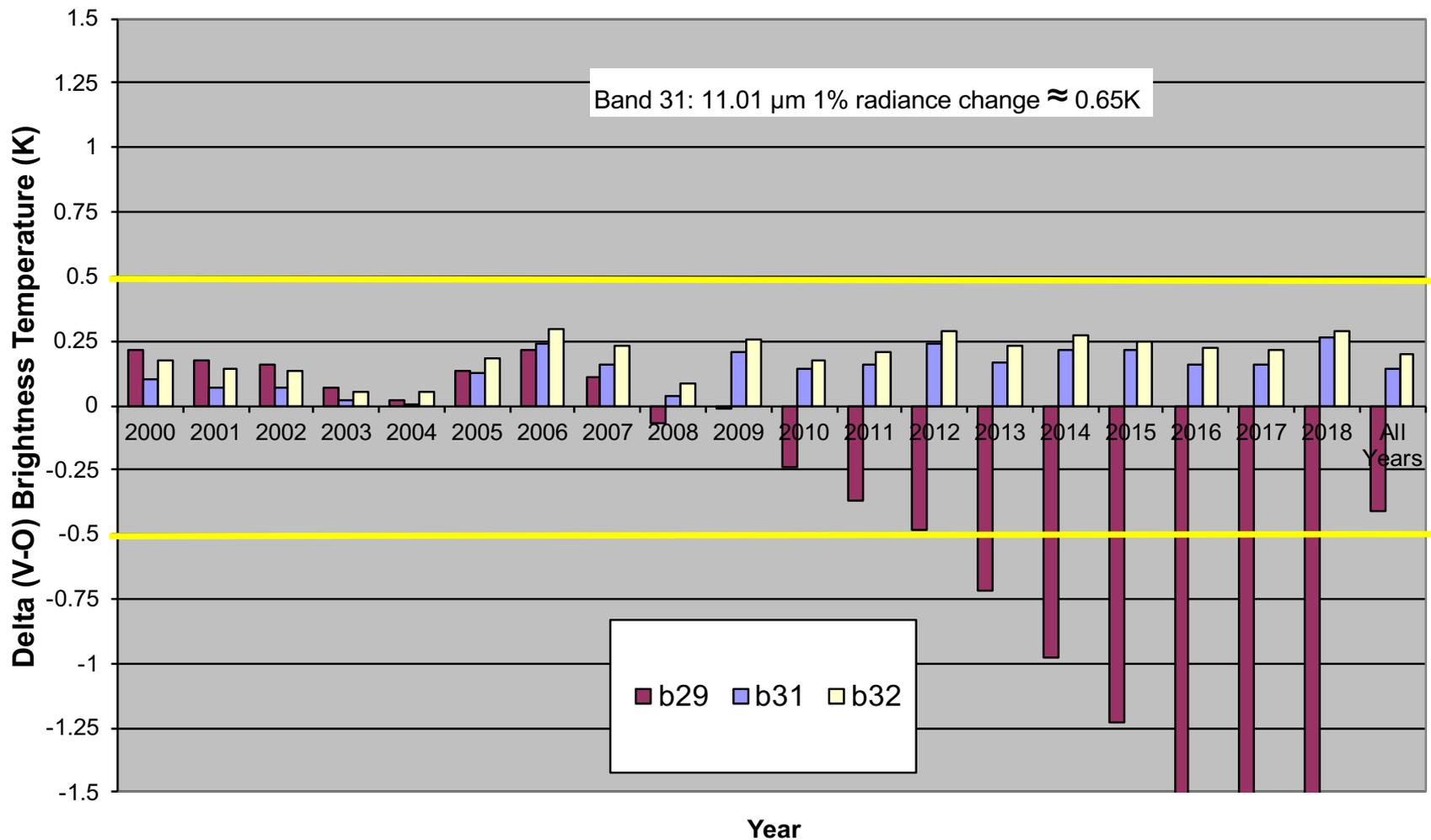
# Aqua-MODIS - Results

**MODIS Terra Vicarious and OBC Thermal Infrared Derived Radiances at Lake Tahoe and Salton Sea CY2000-2018, v5.x**

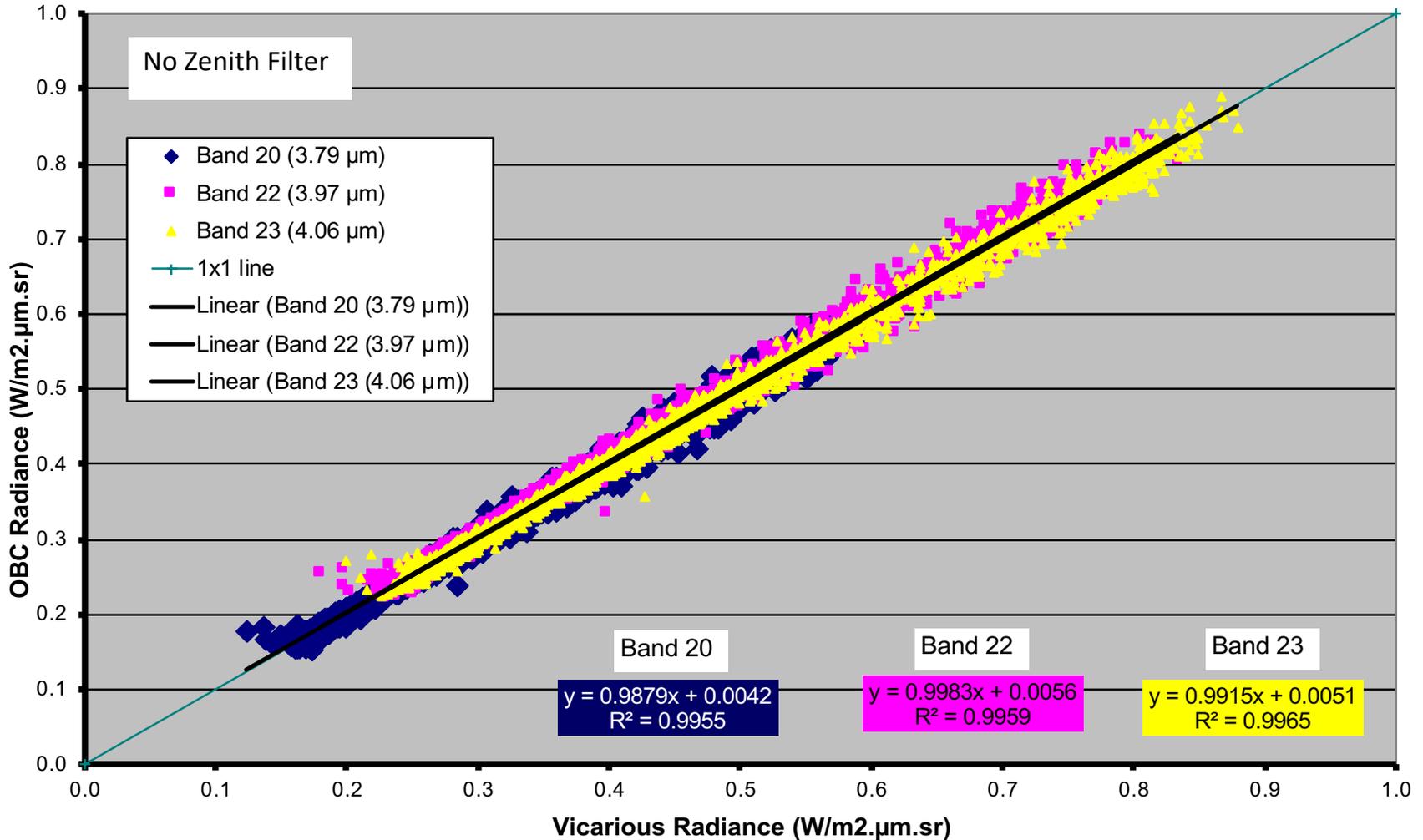


MODIS-Terra – Calibration problem with Band 29.

## Delta Brightness Temperature in TIR Channels for MODIS Terra at Lake Tahoe and Salton Sea CY2000-2018, vz0-30 v5.x

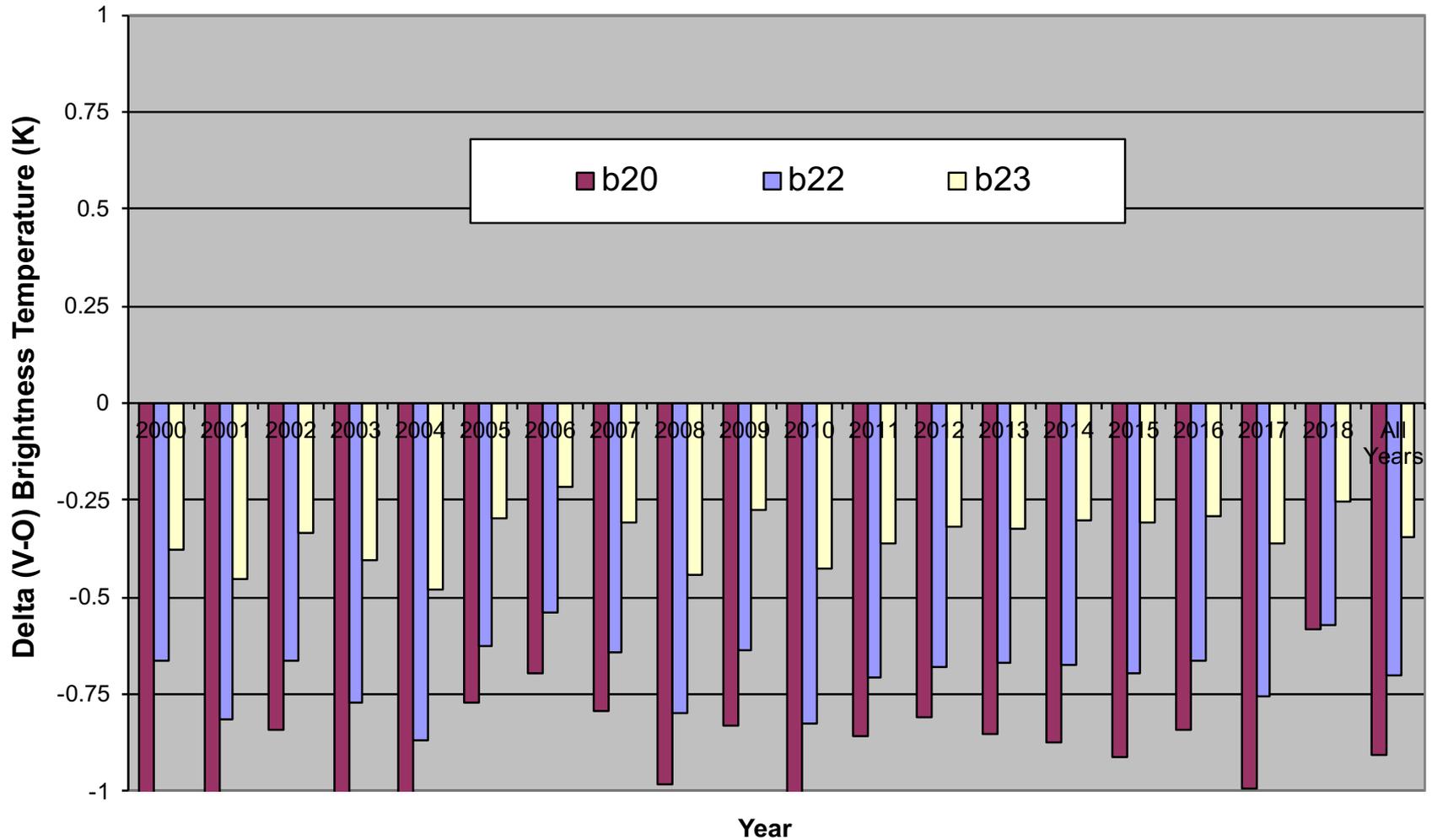


## MODIS Terra Night Only Vicarious and OBC Mid Infrared Derived Radiances at Lake Tahoe and Salton Sea CY2000-2018, v5.x



MODIS-Terra – MIR bands are consistently slightly hot.

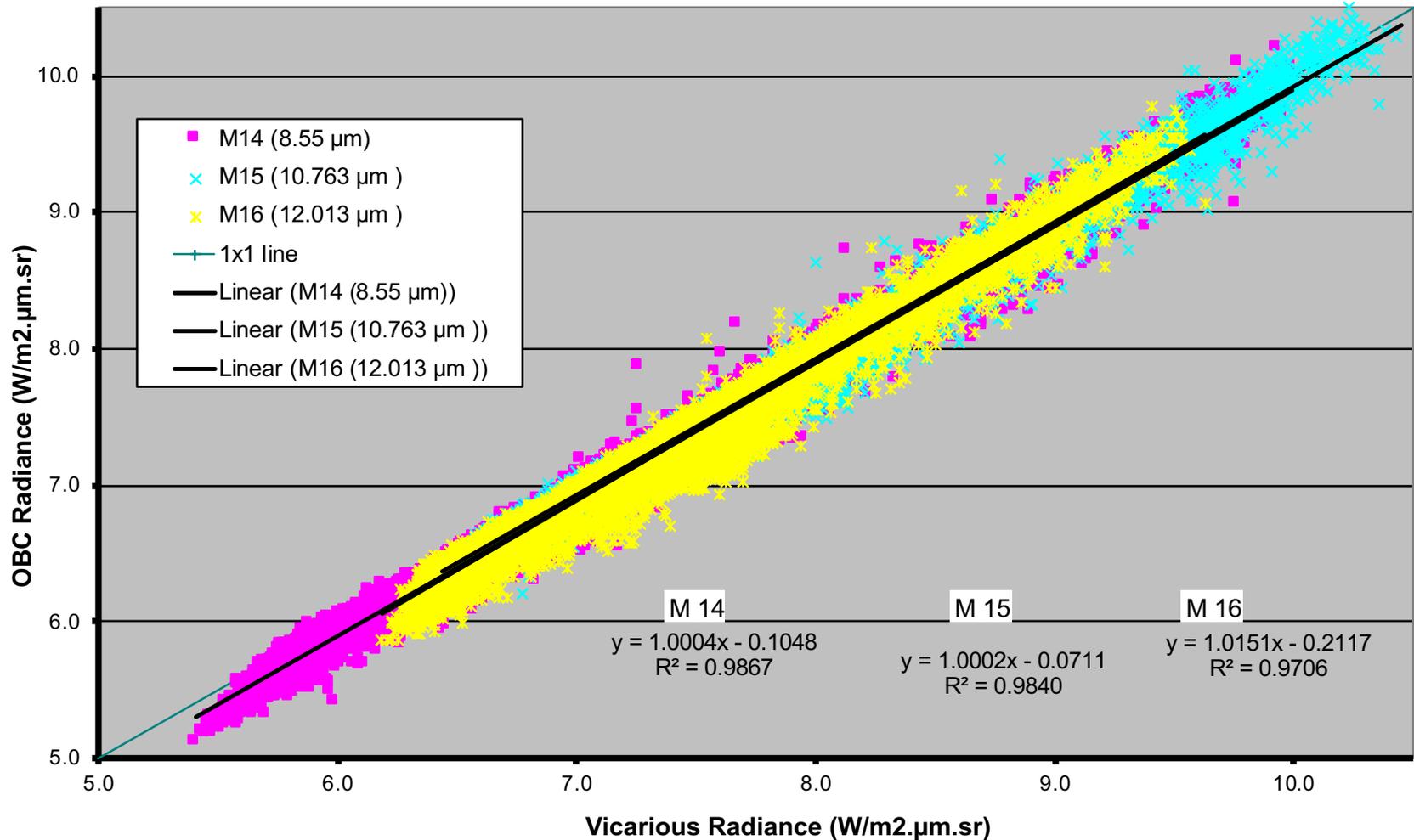
## Delta Brightness Temperature in MIR Bands for MODIS Terra at Lake Tahoe and Salton Sea CY2000-2018, vz0-30, v5.x



MODIS-Terra – MIR bands are consistently slightly hot.

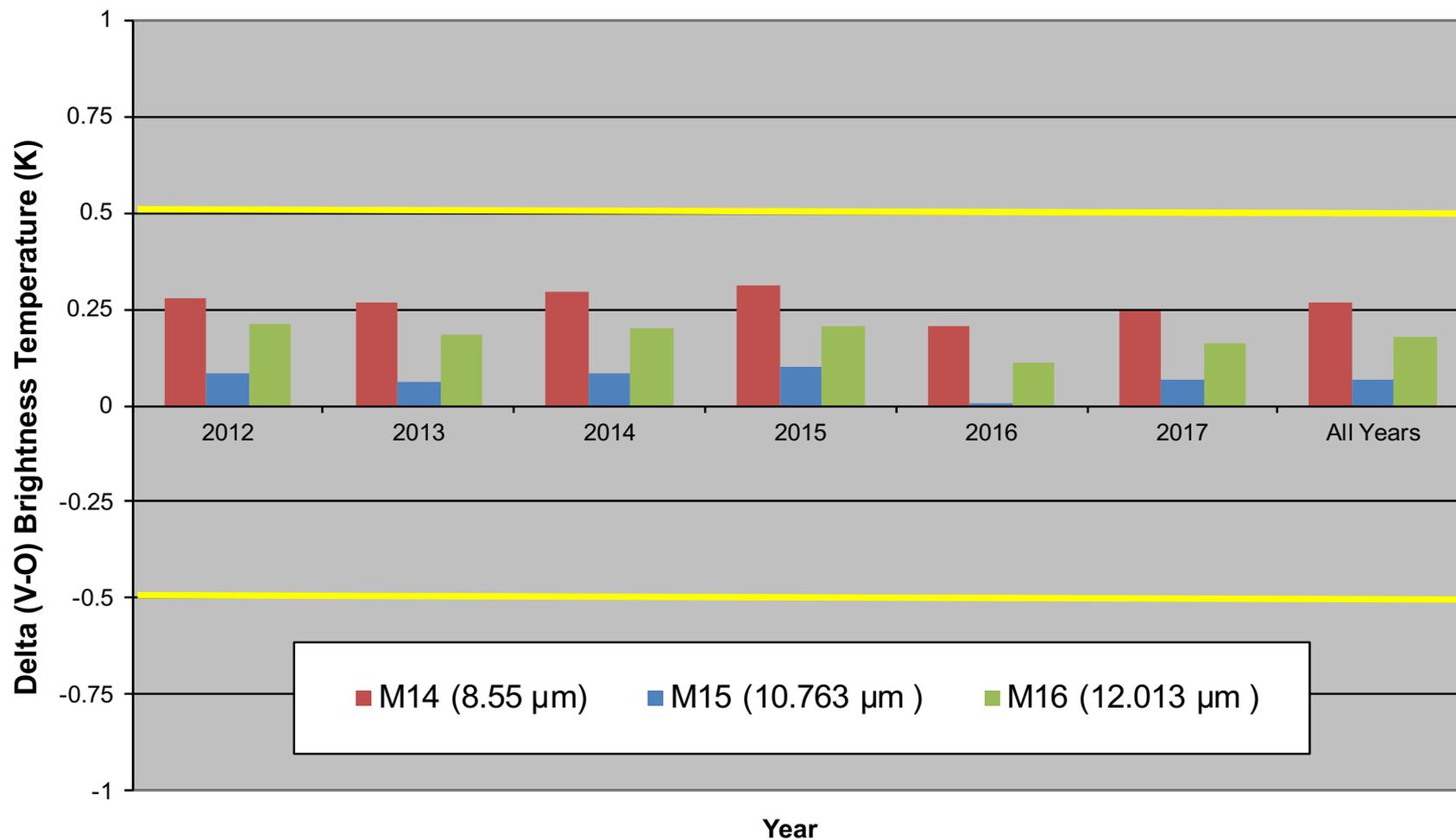
# NPP-VIIRS - Results

## VIIRS NPP Vicarious and OBC Thermal Infrared Derived Radiances at Lake Tahoe and Salton Sea CY2012-17



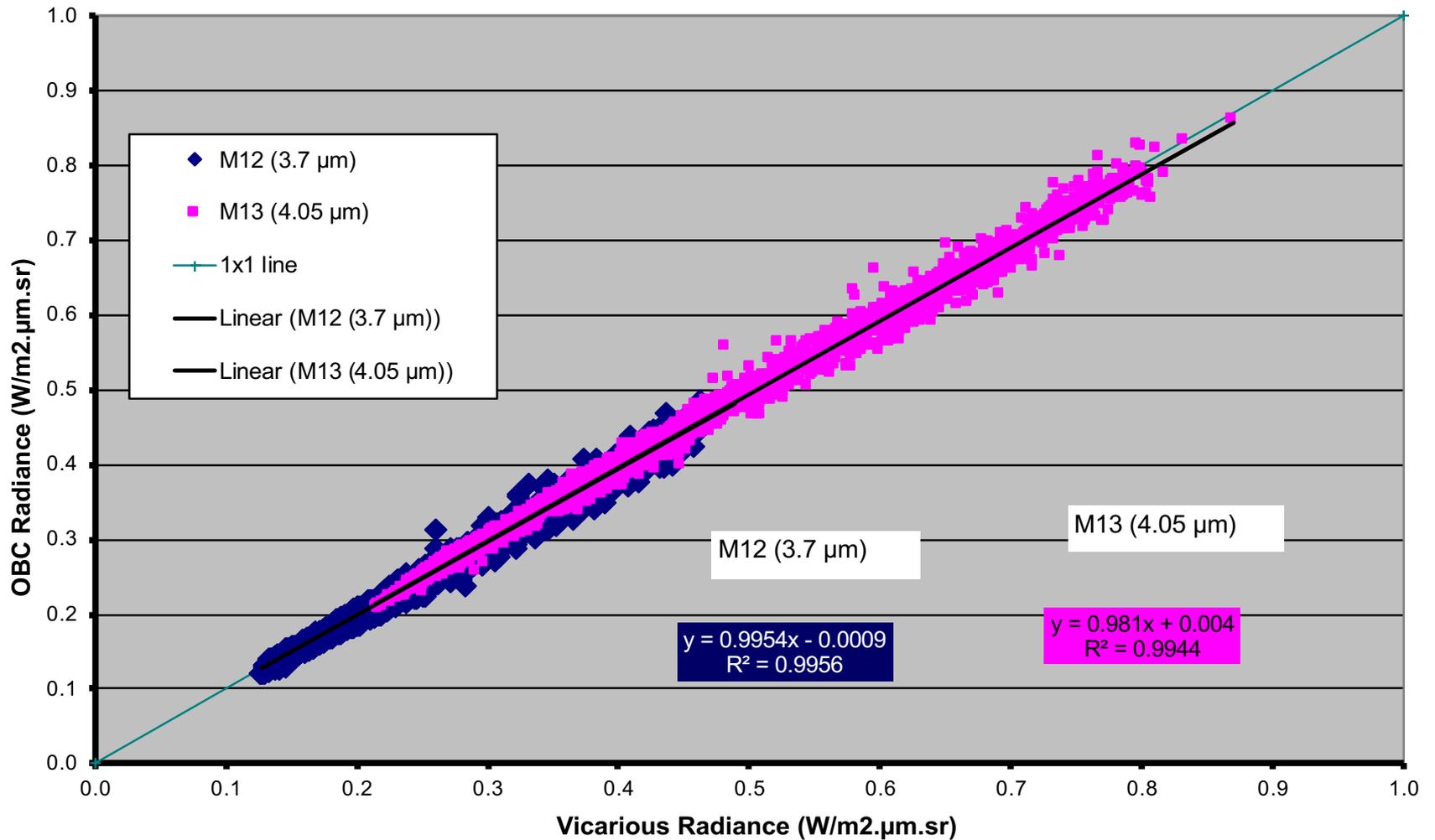
Bands closely follow 1-1 line.

## Delta BT between Vicarious and Observed TIR Channels for NPP VIIRS at Lake Tahoe and Salton Sea By Year VZ 0-30



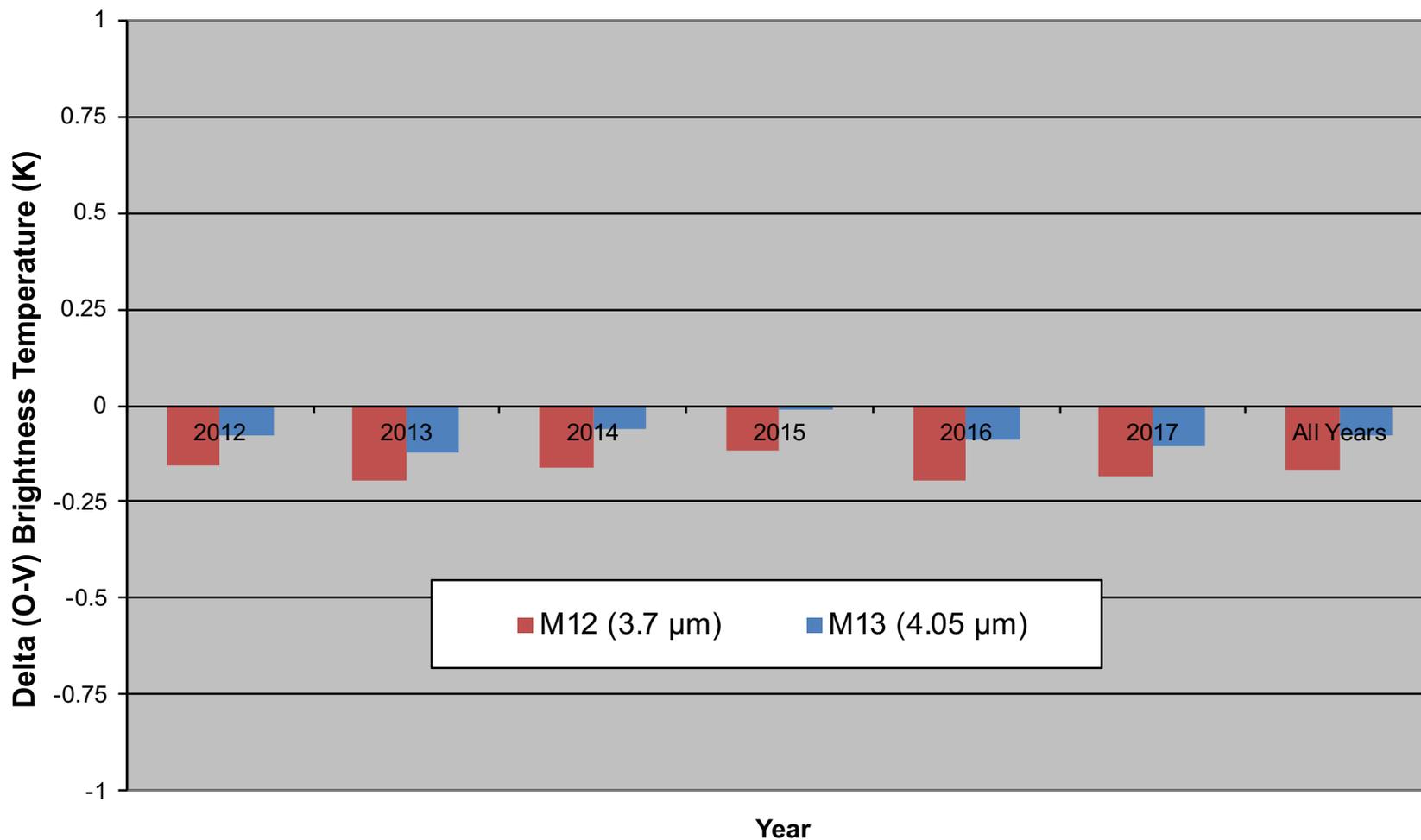
VIIRS – excellent calibration so far.

# NPP VIIRS Night Only Vicarious and OBC Mid Infrared Derived Radiances at Lake Tahoe and Salton Sea



MIR bands also follow 1-1 line.

## Delta BT between Vicarious and Observed in MIR Channels for VIIRS at Lake Tahoe and Salton Sea Nighttime, vz0-30



# 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, MODIS (Terra, Aqua), Landsat 5 and Landsat ETM+, MTI and now VIIRS
- Results:
  - MODIS-Terra at-sensor radiance: TIR bands 31 and 32 no bias, abs. acc.  $\pm 0.3K$ 
    - Gain change in band 29 starting in 2009
  - MODIS-Aqua at-sensor radiance: TIR, no bias, abs. acc.  $\pm 0.3K$
  - NPP-VIIRS at-sensor radiance: TIR, no bias, abs. acc.  $\pm 0.3K$
  - MODIS-Terra at-sensor radiance: MIR, small bias 0.25-0.5 K
    - MODIS Terra MIR is slightly hot!
  - MODIS-Aqua at-sensor radiance: MIR, no bias, abs. acc.  $\pm 0.2K$
  - NPP-VIIRS at-sensor radiance: MIR, no bias abs. acc.  $\pm 0.2K$
- NPP-VIIRS compares well with Aqua-MODIS and is slightly better than Terra-MODIS.

# ECOSTRESS – Preliminary results

## ECOSTRESS Vicarious and OBC Thermal Infrared Derived Radiances at L. Tahoe and Salton Sea CY2018, Std Filter, v1

