Thinking inside the grid:
from multi-instrument satellite data to uniform space-time information

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Introduction

We are exploring methods for combining data from different space-based instruments into meaningful environmental and climate information. STG has been developed to allow the projection of radiance measurements (Level 1) or retrieved data (Level 2) from any instrument to a uniform space-time configuration.

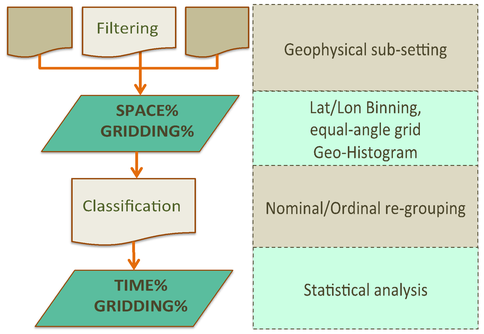
Goal: to compare the measurements or derived products of multiple instrument measurements (with different spatial configurations) mapped to a uniform space-time domain. The STG approach is demonstrated in the comparison of the brightness temperature (BT) difference of two instruments, where sensitivity to co-location and heterogeneity issues are overcome.

Method: Results are calculated for the daytime orbits of two instruments on 1 May 2012 (viewing angles ≤ 39°) gridded to 0.5° /1.0° /2.0° grids

- Imager: Suomi-NPP Visible Infrared Imaging Radiometer Suite (VIIRS)
- Sounder: Suomi-NPP Cross-track Infrared Sounder (CrIS)

- CrIS radiance spectra convolved and converted to VIIRS BT band M15 (~10.8μm).
- CrIS spatial resolution = ~14km; VIIRS spatial resolution = ~1km

Space-Time Gridding (STG) Processing Framework



VM15 = VIIRS band M15 (~10.8μm)
CM15 = CrIS spectra convolved to VM15

Advantages
Global satellite data are processed on the fly as research needs arise
Output grid size is dynamically determined by the research application
Time averages can be any length of time (number of days ≥ 1)
Instrument independent any GEO or LEO instrument can be processed and/or combined
Fast, Transparent, Easy, Simple Requires basic computer resources only, processes a day of data in minutes

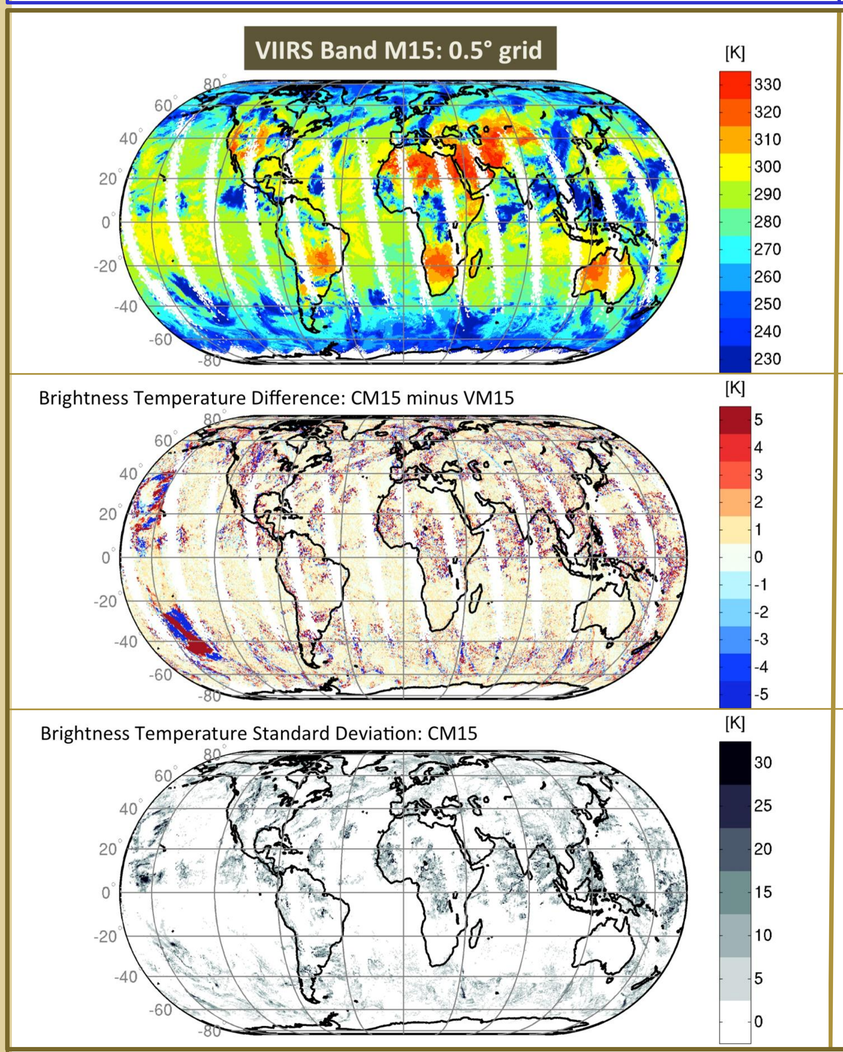
Calculate statistics from uniform scenes only to avoid cloud contamination

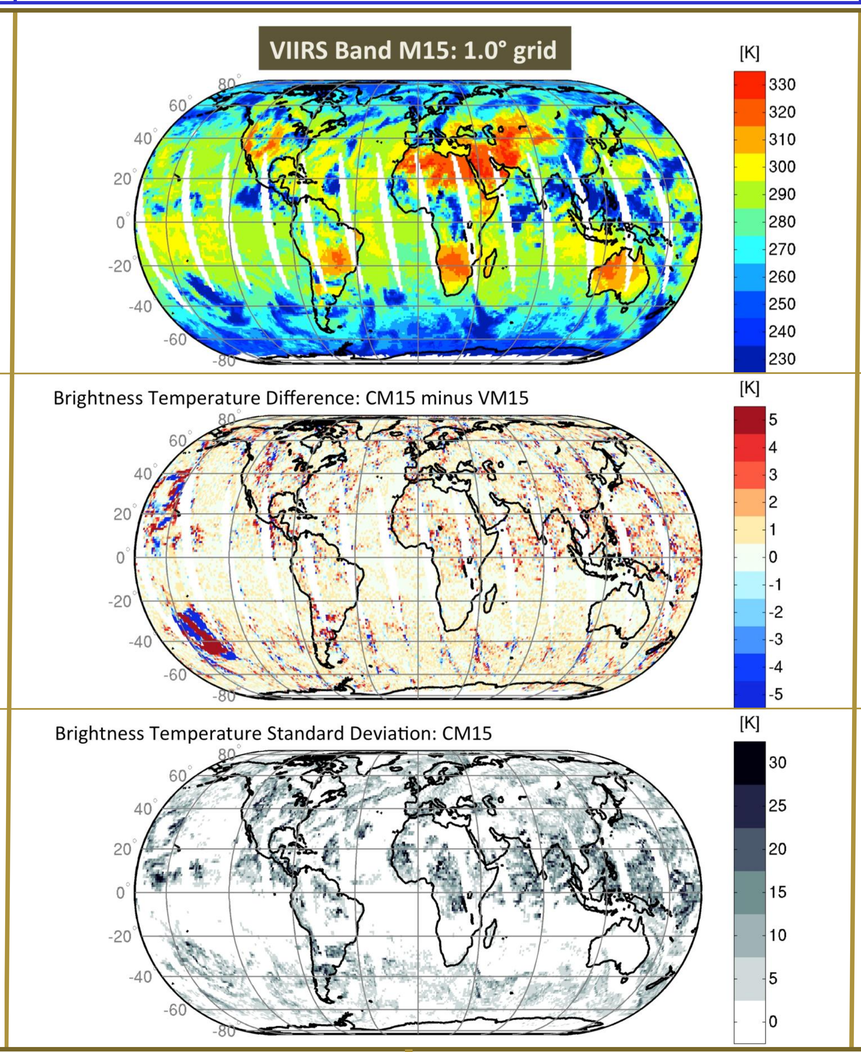
Uniformity test: CM15 grid cell standard deviation < threshold [K]
Heterogeneity test: absolute value of difference (CM15 minus VM15) < threshold [K]

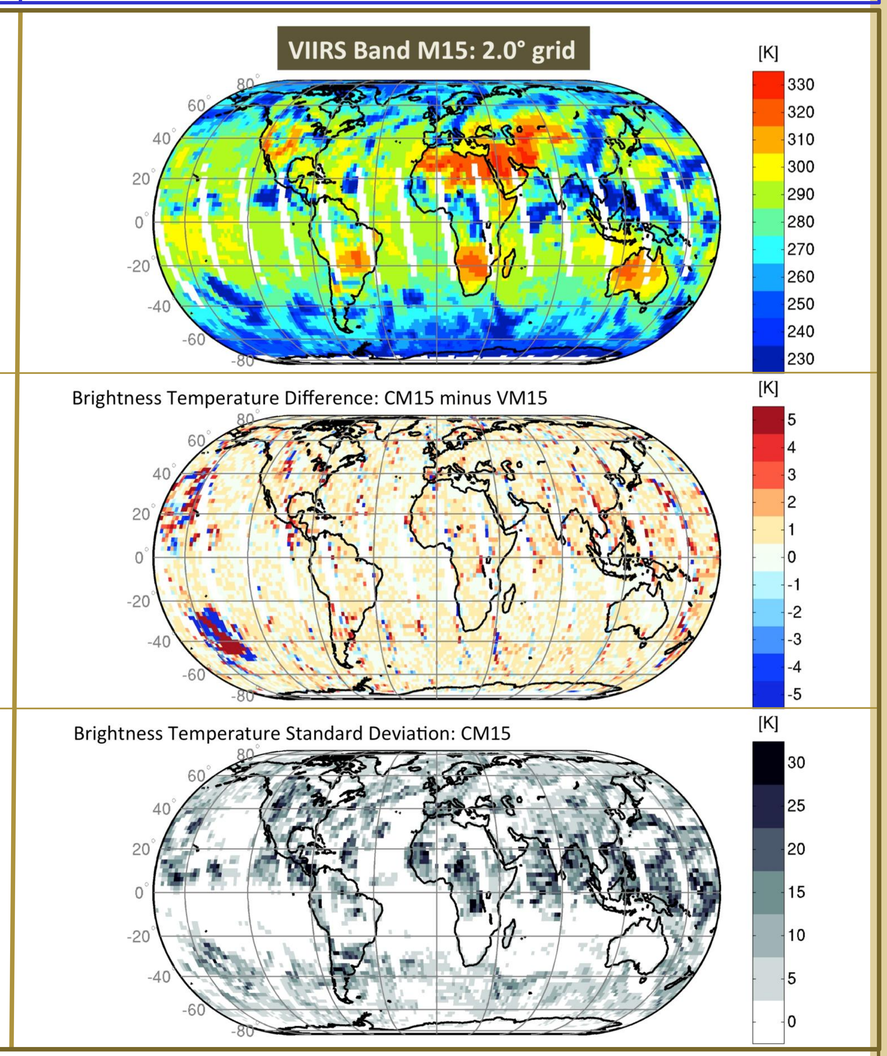
Table 1: Global Daily Mean Difference [K] with a uniformity threshold of 2K (a value below which results do not improve significantly). With traditional colocation methods Tobin et al.[1] calculated a daily mean of ~0.1K.

Heterogeneity threshold [K]	0.5° grid (ng[2] = ~200k)	1.0° grid (ng = ~54k)	2.0° grid (ng = ~14k)
5	**0.48** (41%)[3]	**0.42** (64%)	**0.45** (51%)
2	**0.43** (40%)	**0.36** (28%)	**0.39** (16%)
1	**0.36** (36%)	**0.34** (27%)	**0.39** (16%)
0.5	**0.24** (24%)	**0.27** (21%)	**0.34** (12%)
0.2	**0.04** (6%)	**0.07** (5%)	**0.06** (2%)

[1] Tobin et al. (2006) JGR, vol. 11, doi: 10.1029/2005JD006095; Tobin et al. (2013) CrIS/VIIRS Comparisons, GSICS Annual Meeting, Willimalsburg, VA, 3-8 March.
[2] ng = total number of global grid cells; i.e., available sample size
[3] Percentage of total grid cells in brackets, i.e., statistical sample size







Conclusions: For multi-instrument global analysis, time/resource expensive co-location schemes are not necessary if uniform scenes are selected correctly. Global statistics are insensitive to grid cell size as long as a significant sample size is maintained. Sub-pixel heterogeneity should be carefully considered.

The STG algorithm is described here:

- Smith, N, W.P Menzel, E. Weisz, A. Heidinger and B.A. Baum. 2013. A uniform space-time gridding algorithm comparison of satellite data products: Characterization and sensitivity studies. *Journal of Applied Meteorology and Climatology*, 52: 255–268, doi: 10.1175/JAMC-D-12-031.1.
- CIMSS Science Symposium http://www.youtube.com/user/UWSSEC/featured