Supplementary Materials for

Large regional shortwave forcing by anthropogenic methane informed by Jovian observations

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Fig. S1. Time evolution of CH$_4$ spectroscopic properties catalogued in the HITRAN databases. Numbers of CH$_4$ lines (red line), including isotopologues, and the maximum wavelengths of CH$_4$ line centers (green line), also including isotopologues, tabulated in successive versions of HITRAN versus the years when each version was released (10, 11).
Fig. S2. Change in column-integrated CH$_4$ optical depth between RTMIP experiments 3b (2000 CE conditions) and 3d (1860 CE conditions) using the HITRAN 2000 line database.
Fig. S3. Perturbations to changes in column-integrated CH$_4$ optical depth between RTMIP experiments 3b and 3d. Perturbation arise due to substituting the HITRAN 2004, 2008, and 2012 (blue, green, and red lines, respectively) for the HITRAN 2000 line database.
Fig. S4. Cumulative perturbations to changes in CH$_4$ direct, instantaneous, unadjusted spectral forcing between RTMIP experiments 3b and 3d due to substituting the HITRAN 2004, 2008, and 2012 line databases for the HITRAN 2000 line database. Perturbations for the successive databases and for the Jovian spectral data (blue, green, red, and black lines, respectively) are plotted at the top of atmosphere, tropopause, and surface. The forcing perturbations represent the integrals from 2000 cm$^{-1}$ to any given wavenumber.
Fig. S5. Near-infrared black-sky surface albedo retrieved from MODIS for 2003 to 2014 CE. Panel A: Time-mean of all retrieved albedo values gridded to the 0.05° CMG resolution. Panel B: Corresponding standard deviations of albedos on the same grid.
Table S1. The variable names, source model components, and descriptive names of the monthly mean fields used as input to the OSSE from the Coupled Model Intercomparison Project - Phase 5 (26) (CMIP5).

| CMOR variable | Model Domain | Field                                                      |
|---------------|--------------|------------------------------------------------------------|
| cl            | Amon         | Cloud Area Fraction                                        |
| cli           | Amon         | Mass Fraction of Cloud Ice                                |
| clw           | Amon         | Mass Fraction of Cloud Liquid Water                       |
| hur           | Amon         | Relative Humidity                                          |
| hus           | Amon         | Specific humidity                                         |
| ps            | Amon         | Surface pressure                                          |
| rlus          | Amon         | Surface Upwelling Longwave for Offline Radiation           |
| sfcWind       | Amon         | Near-Surface Wind Speed                                   |
| sftlf         | fx           | Fraction of Surface Area Covered by Land                  |
| sic           | OImon        | Sea Ice Area Fraction                                     |
| snc           | LImon        | Snow Area Fraction                                        |
| snd           | LImon        | Snow Depth                                                 |
| ta            | Amon         | Temperature                                                |
| ts            | Amon         | Surface Temperature                                       |