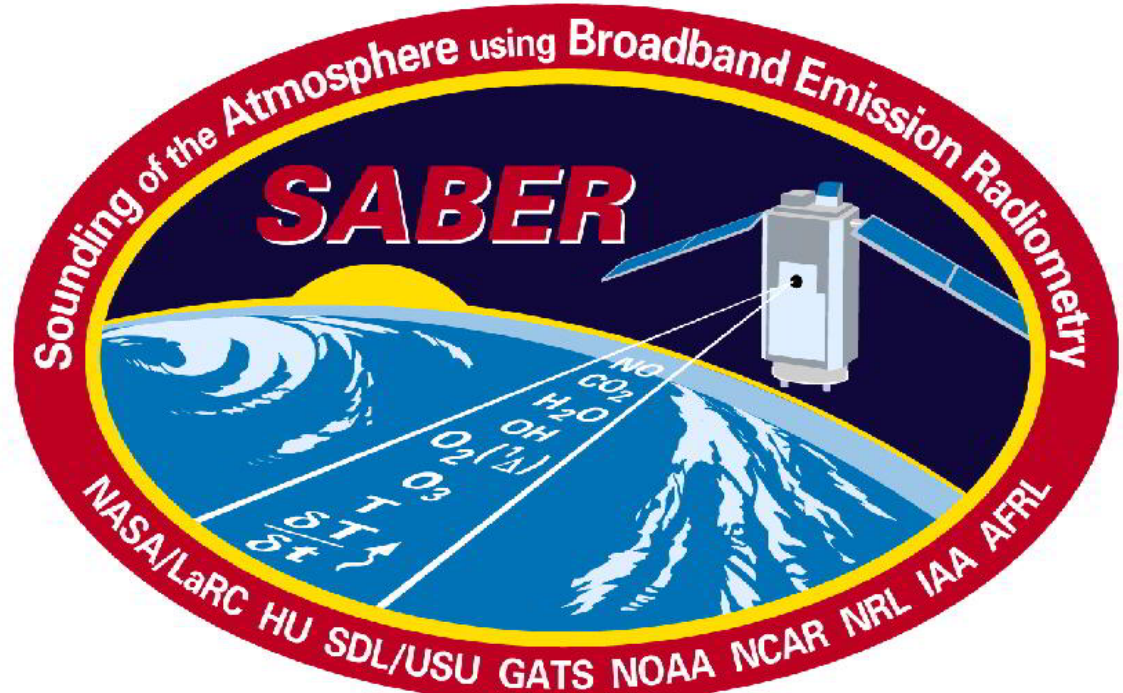
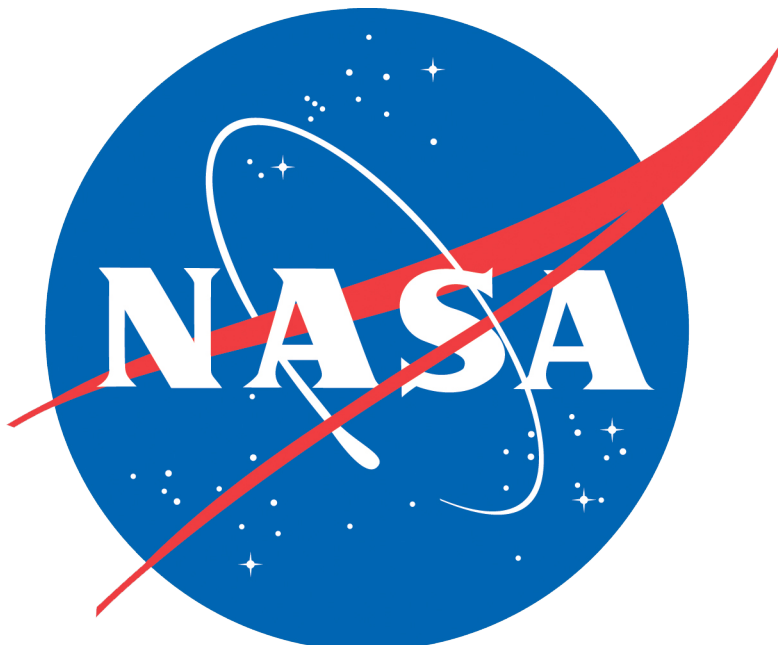




Thermospheric response to substorms as observed by the SABER instrument

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BACKGROUND

Introduction

The climate of the thermosphere is controlled in part by cooling to space driven by infrared radiation from nitric oxide (NO, 5.3 μ m), carbon dioxide (CO₂, 15 μ m), and atomic oxygen (O, 63 μ m). The Sounding of the Atmosphere using Broadband Emission Radiometry (SABER) instrument on the Thermosphere-Ionosphere-Mesosphere Energetics and Dynamics (TIMED) satellite measures the vertical distribution of infrared radiation emitted by various atmospheric gases (ozone, water vapor, as well as nitric oxide, and carbon dioxide), providing important information about the radiation budget in the upper atmosphere.

SABER was launched in December 2001 and began making measurements in January 2002. From these radiance measurements, we have more than 15 years of derived scan fluxes and global daily infrared power and energy radiated by NO and CO₂ in the thermosphere.



SABER Channels and Data Products

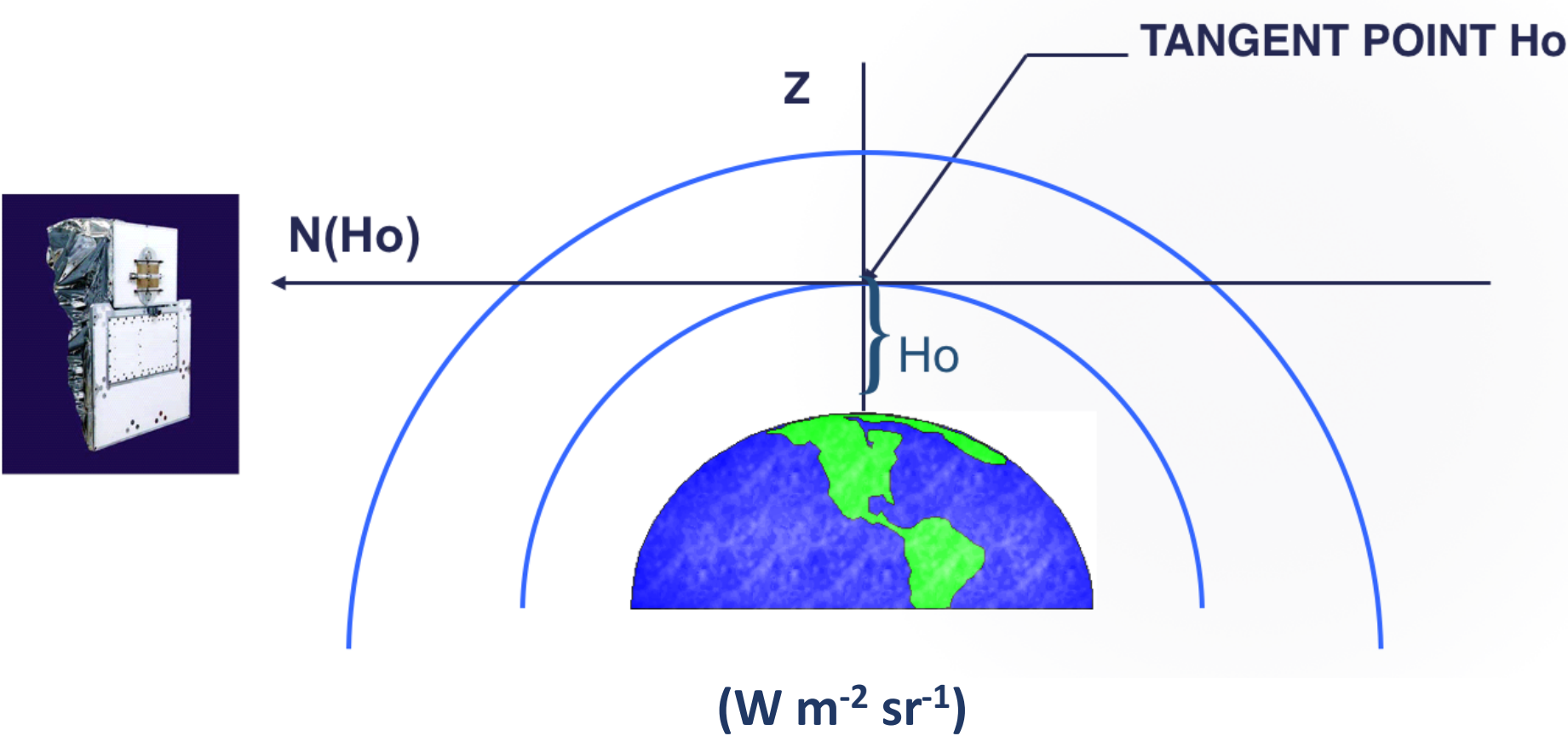
Species	Wavelength	Data Products	Altitude Range
CO ₂	15.2 μ m	Temperature, pressure, cooling rates	15-100 km
CO ₂	15.2 μ m	Temperature, pressure, cooling rates	15-100 km
CO ₂	14.8 μ m	Temperature, pressure, cooling rates	15-100 km
O ₃	9.6 μ m	Day and Night Ozone, cooling rates	15-95 km
H ₂ O	6.3 μ m	Water vapor, cooling rates	15-80 km
CO ₂	4.3 μ m	Carbon dioxide, dynamical tracer	90-160 km
NO	5.3 μ m	Thermospheric cooling	100-300 km
O ₂ (¹ D)	1.27 μ m	Day O ₃ , solar heating; Night O	50-100 km
OH(u)	2.0 μ m	Chemical Heating, photochemistry	80-100 km
OH(u)	1.6 μ m	Chemical Heating, photochemistry	80-100 km

Over 30 data products including T, CO₂, O₃, VER, O, H, $\partial T / \partial t$

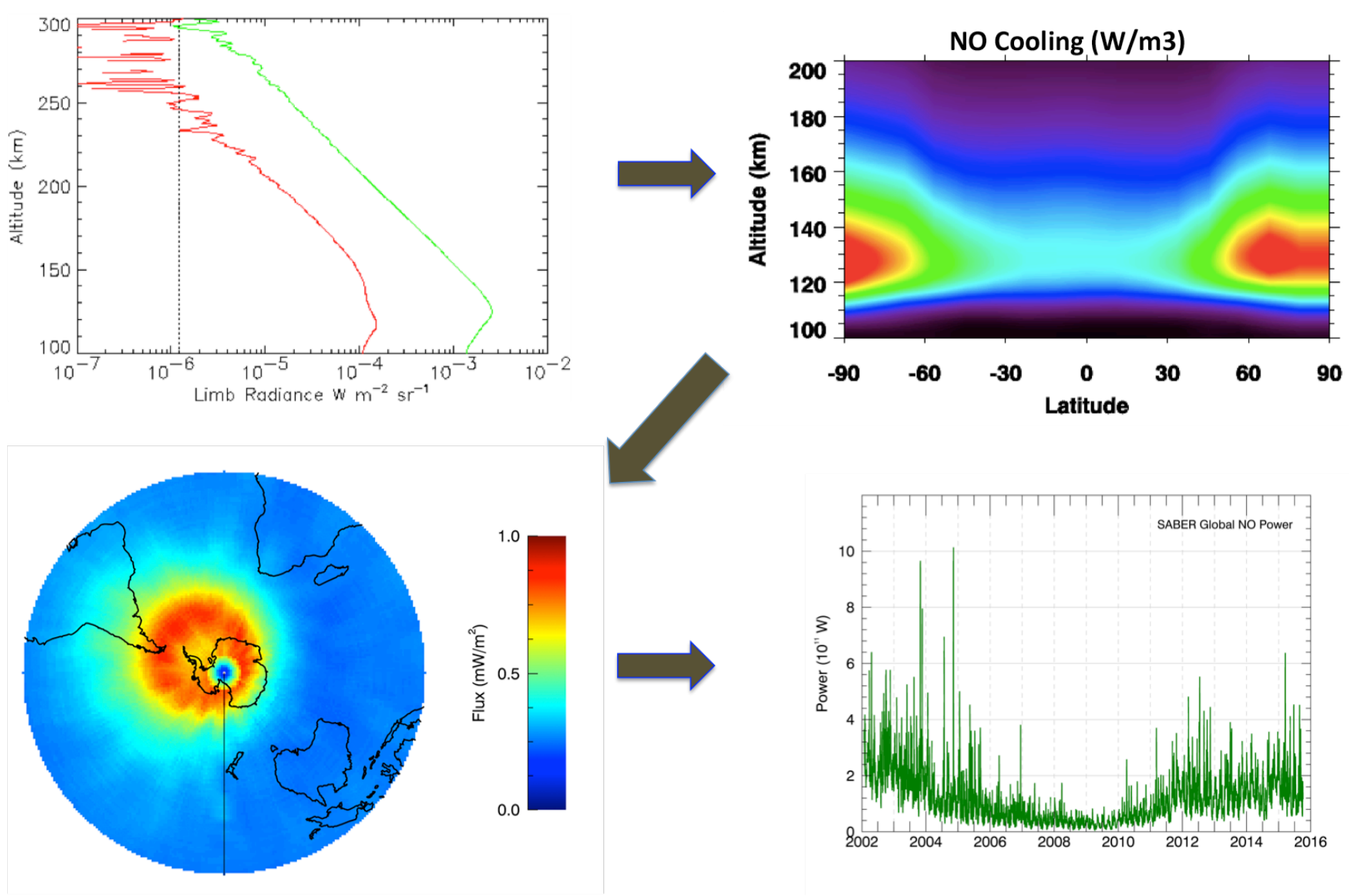
METHODOLOGY

The SABER instrument is a broadband radiometer that measures spectrally integrated infrared radiance in 10 bands between 1.27 and 15 μ m as it continuously scans the Earth's limb from the surface to about 400 km.

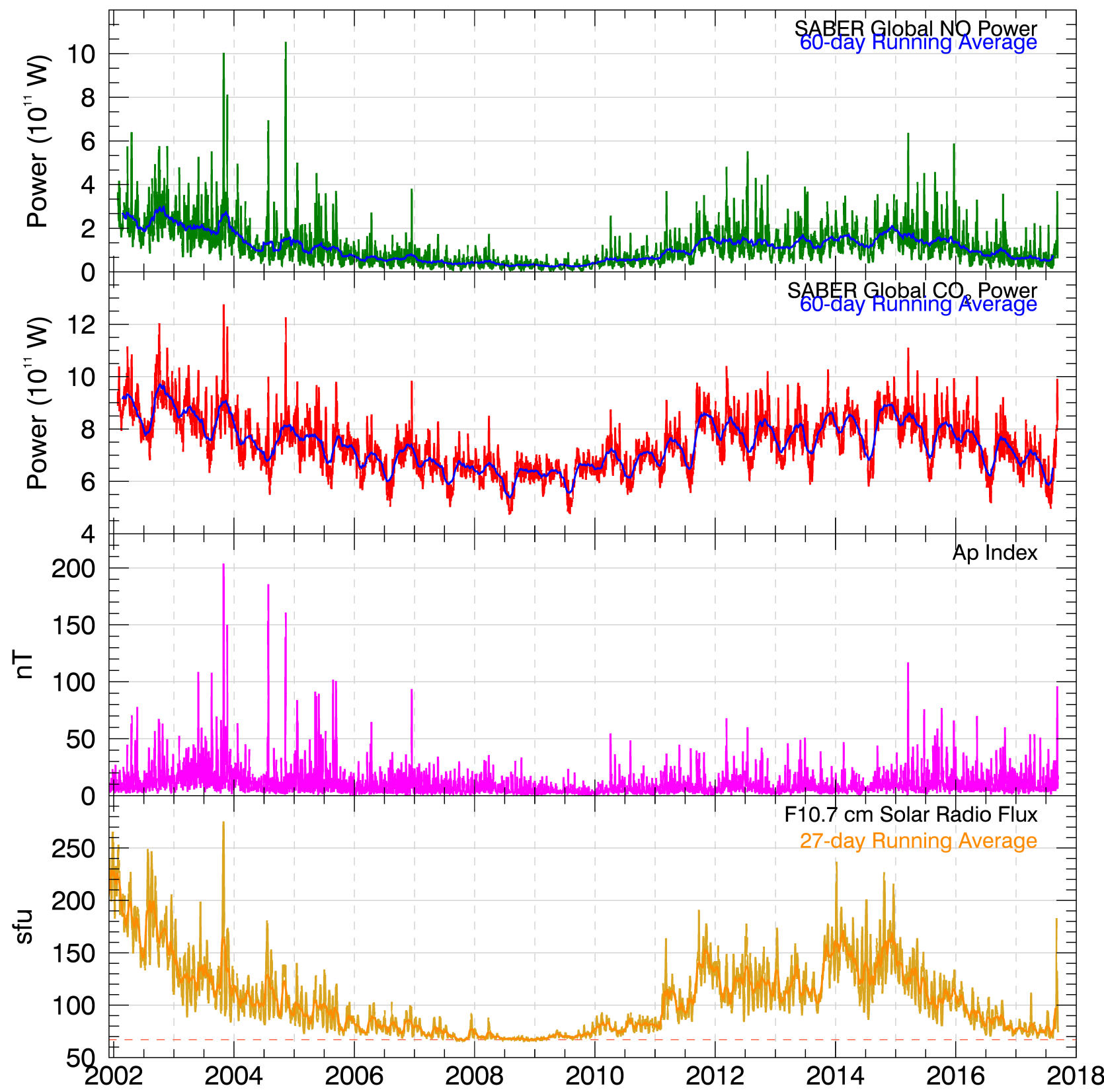
SABER Viewing Geometry



Thermosphere Global Cooling Power Derivation



Infrared radiative cooling by nitric oxide (NO) and carbon dioxide (CO₂) modulates the thermosphere's density and thermal response to geomagnetic storms. Physically, changes in NO emission are due to changes in temperature, atomic oxygen, and the NO density. These physical changes, however, are driven by changes in solar irradiance and changes in geomagnetic conditions and as a result NO acts as a natural thermostat to cool the atmosphere, reducing the energy deposited by a solar storms.



RESULTS

Substorm Identification

Criteria:

- must have a meso-scale to large-scale spatial size
- must last tens of minutes but not more than a few hours
- must be associated with a reconfiguration of the magnetosphere

Discussion

These all point to a considerable energy release. "Considerable" needs to be quantified. Excludes events that took place in the 06-18 MLT (dayside) range. Typically these are shorter and located around noon. Other ways of defining substorm activity in the thermosphere?

Examples from the Halloween 2003 and November 2004 Superstorms

NO profile flux – each scan's volume emission rate integrated vertically from 100-250 km

- Latitudes between 55 N/S
- Latitudes poleward of 55 N/S

CO2 profile flux –

- Latitudes between 55 N/S
- Latitudes poleward of 55 N/S

SuperMAG AE Index (SME) – a version of the AE index derived from magnetometer data provided by the SuperMAG collaborators <http://supermag.jhuapl.edu/indices>

