IONOSPHERIC MODELS

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OUTLINE

- CURRENT MODELS
- INPUTS REQUIRED
- PRODUCTS AND OUTPUTS FOR USERS
- HOW NASA CAN HELP
- WHAT LWS SHOULD SUPPLY

CURRENT IONOSPHERIC MODELS

RESEARCH

- Global Theoretical Ionospheric Model (GTIM)
- Field Line Interhemispheric Plasma Model (FLIP)
- USU model of the global ionosphere
- A Coupled Thermosphere-Ionosphere-Plasmasphere Model (CTIP)
- Thermosphere-Ionosphere-Mesosphere-Electrodynamic-General Circulation Model (TIME-GCM)

OPERATIONAL

- Parameterized Real-time Ionospheric Specification Model (PRISM)
- Ionospheric Forecast Model (IFM)
- Coupled Ionosphere-Thermosphere Forecast Model (CITFM)

MODEL INPUT REQUIREMENTS

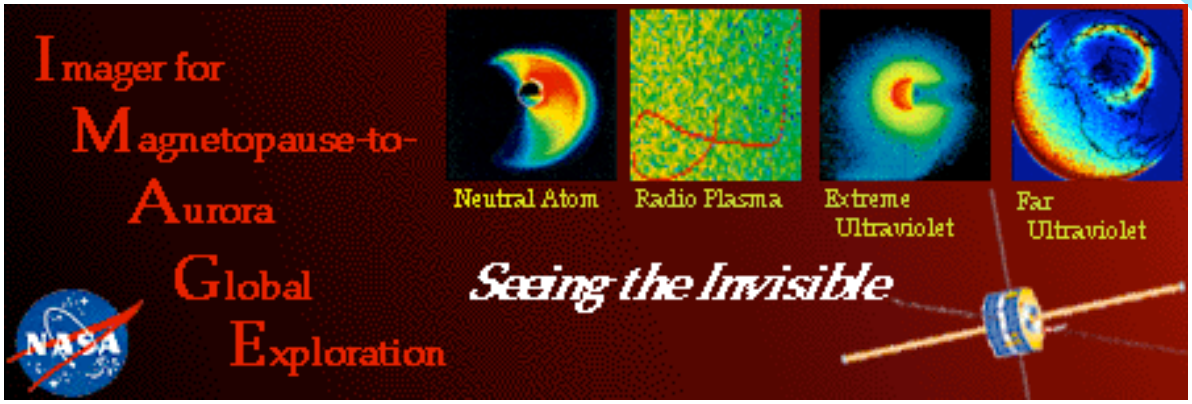
RESEARCH

- E X B drifts at low and high latitudes (1)
- Meridional neutral winds at mid latitudes (1)
- High latitude energetic particle precipitation (1)
- Neutral atmosphere for uncoupled models (1)
- Solar EUV radiation fluxes (2)
- Electron and ion temperatures (3)
- Zonal neutral winds (4)
- Lower atmosphere tides (1)
- Kp, F10.7, Ap, IMF (1)

OPERATIONS

- Ionospheric densities, peak parameters and TEC (1) for PRISM
- E X B drifts, neutral winds, particle precipitation (1) for IFM and CITFM
- Kp, F10.7, Ap, IMF (1)

Future Data:
IMAGE Satellite



NASA Explorer Series Satellite

Operational in February, 2000

- Energetic Neutral Atom Imagers
- Far Ultraviolet Imager
- Extreme Ultraviolet Imager
- Radio Plasma Imager

Multiple Ground Stations to Provide Real-Time Data

Products from IMAGE

- Auroral Oval - Situational Awareness
- Auroral Oval - Energy Deposition
- Magnetopause and Plasma-pause Locations
- Ring Current Ion Flux

Future Data: NPOESS

Identify Users and Define User Needs (Parallel Efforts in DoD)

- NASA Manned Space Mission
- NASA Low-Earth-Orbit Satellites
- Electric Power Companies
- FAA Navigation
- Global Telecommunications
- Global Navigation

Requirement Areas

- Orbital Drag
- Ionospheric Effects and Scintillation
- Satellite Design and Anomaly Resolution

NPOESS Measurement Requirements

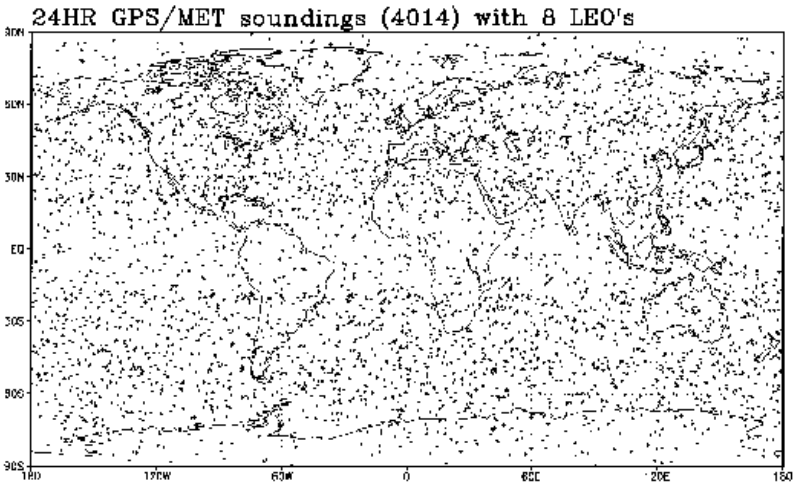
- Auroral Boundary
- Auroral Energy Deposition
- Auroral Imagery
- Electric Field
- Electron Density Profile
- Geomagnetic Field
- In-situ Plasma Fluctuations
- In-situ Plasma Temperature
- Ionospheric Scintillation
- Neutral Density Profile
- Medium Energy Charged Particles
- Energetic Ions
- Supra-thermal to Auroral Energy Particles
- Neutral Winds

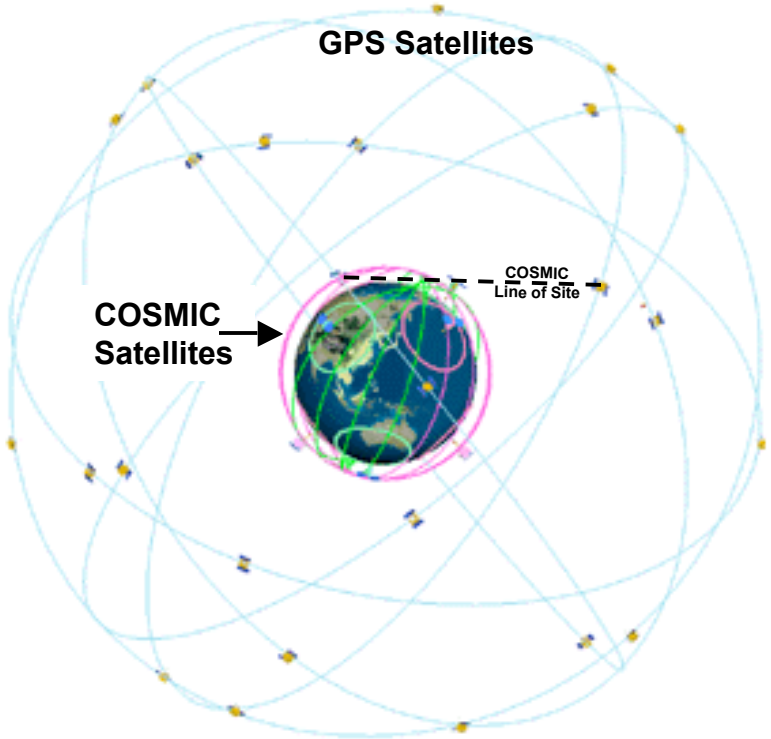
Future Data: COSMIC

(Constellation Observing System for Meteorology, Ionosphere, and Climate)
Measurements of TEC and Electron Density Profiles

An international (NSPO (Taiwan), UCAR, JPL) fleet of 8 low-Earth-orbit spacecraft with GPS receivers to be launched in 2001

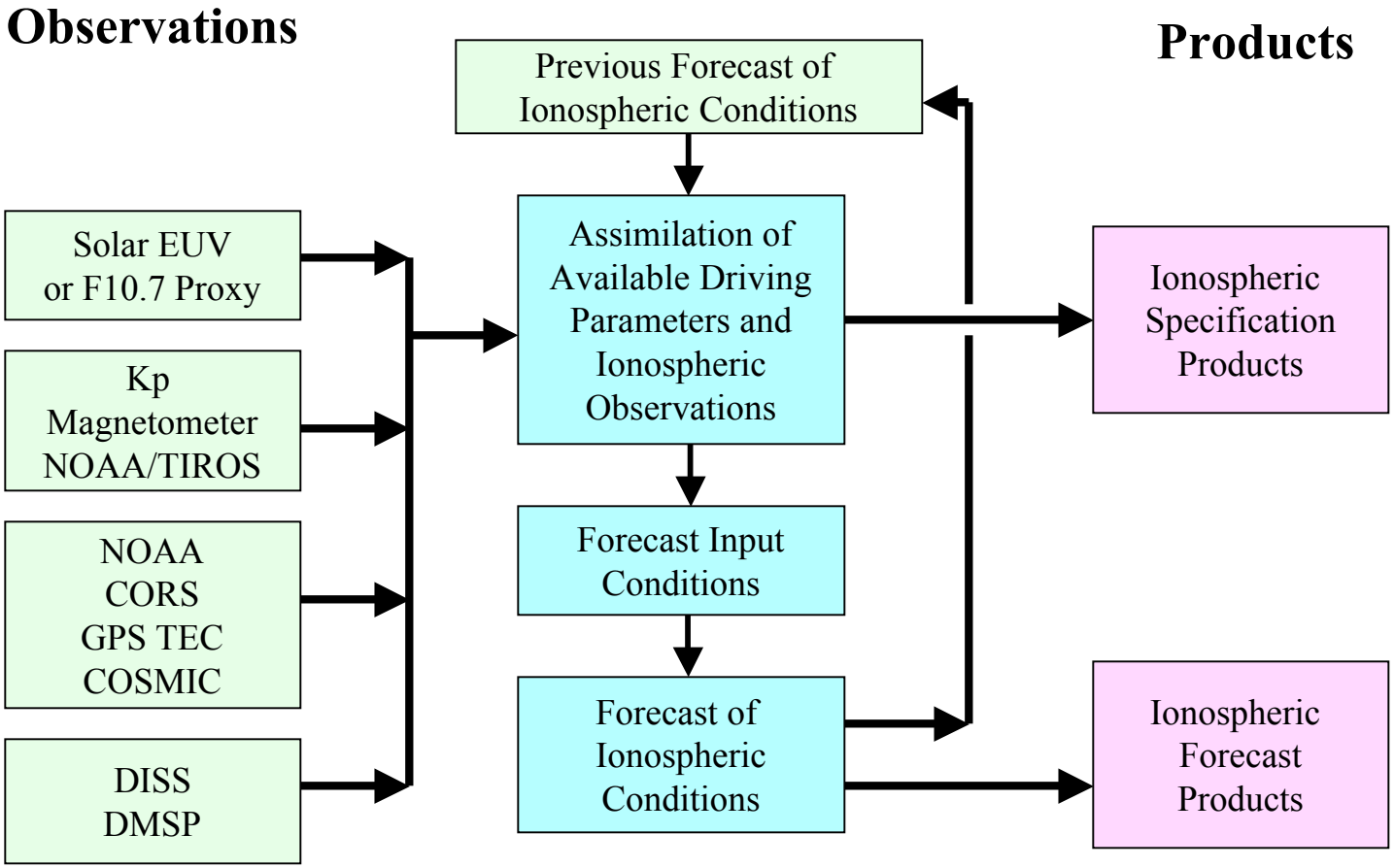
- Using occultation of the GPS signal as it passes through the ionosphere, height profiles of electron densities will be obtained.
- During a 24 hour period, 8 spacecraft will obtain 4014 ionospheric soundings
- Data products will be global Total Electron Content (TEC) and Electron Density Profiles





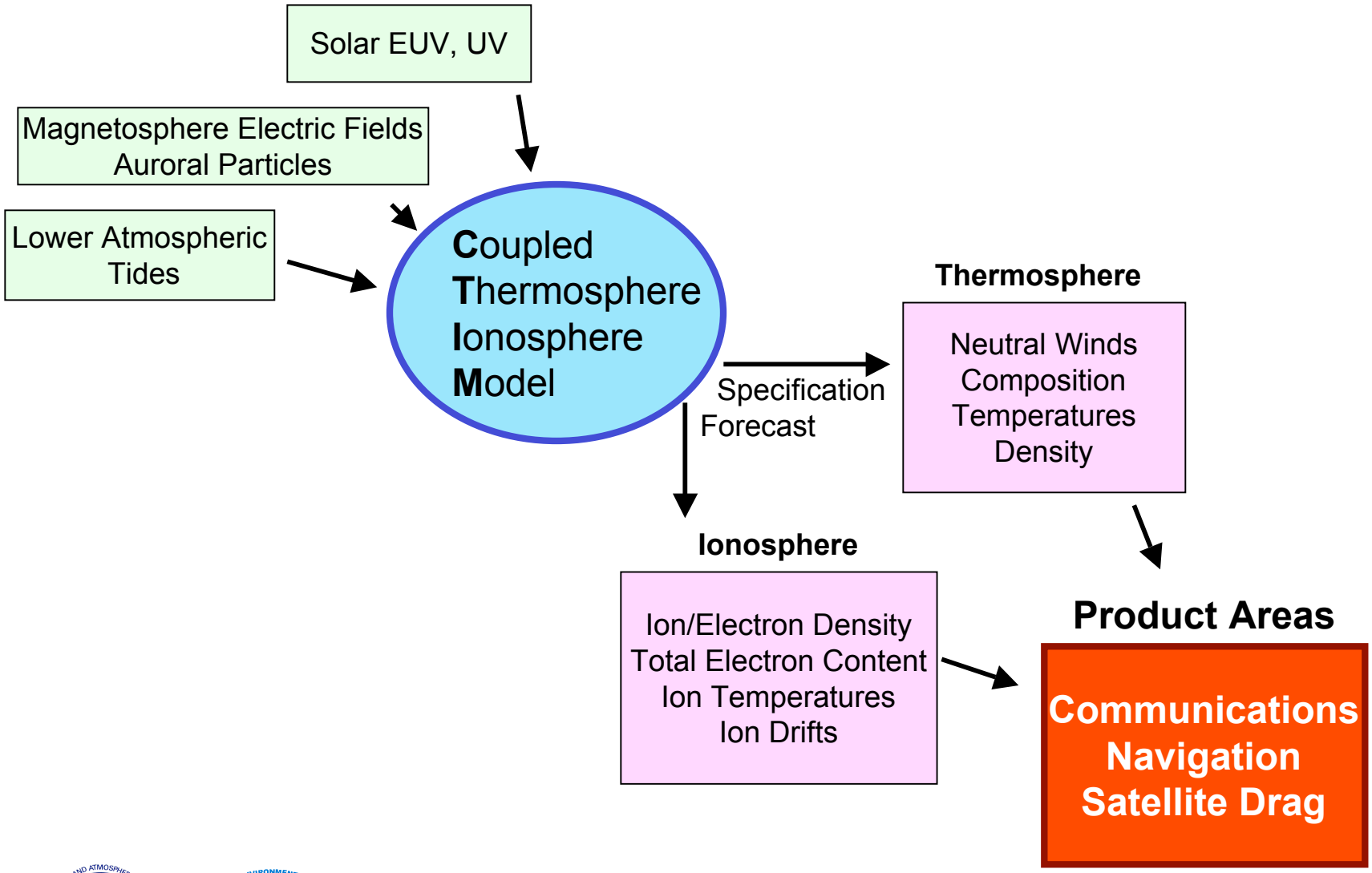
THE FUTURE:

Data Assimilation Approach for Ionospheric Products



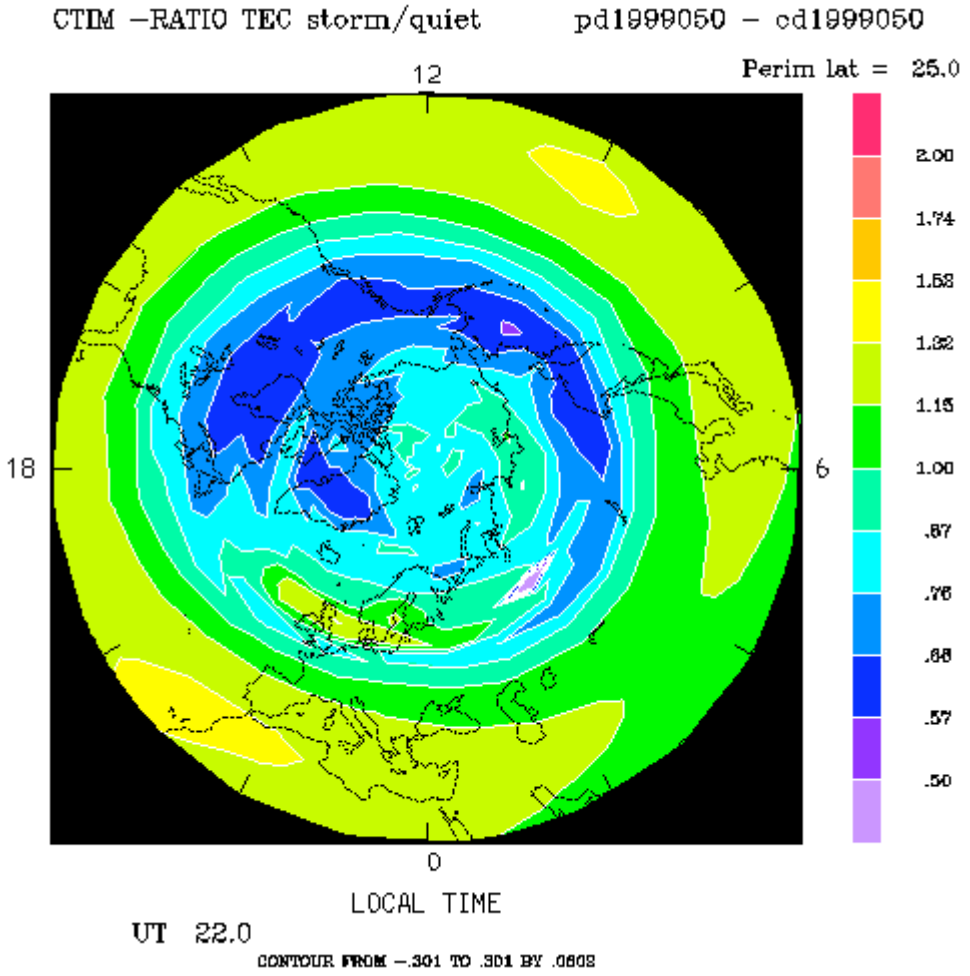
An Example of Model Implementation

Coupled Thermosphere-Ionosphere Model (CTIM)



Product:
Ionospheric Variability Maps

- Hourly maps of ionospheric variability created from modeled predictions
- Shows the deviation from the average quiet condition
- Can be easily modified to a number of specific applications such as GPS position errors
- Similar maps of NmF2 can be used to produce HF propagation predictions



Product:
Equatorial Scintillation Forecast

Problem:

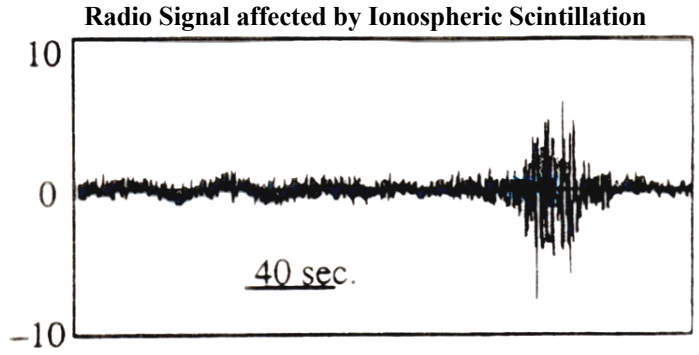
- Ionospheric irregularities near the magnetic equator produce some of the largest errors in the GPS signals. These irregularities are quite sporadic.

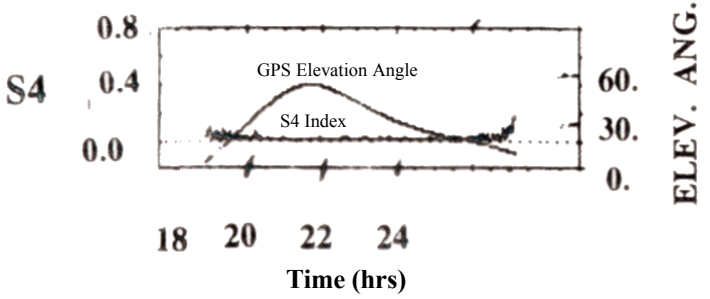
Solution:

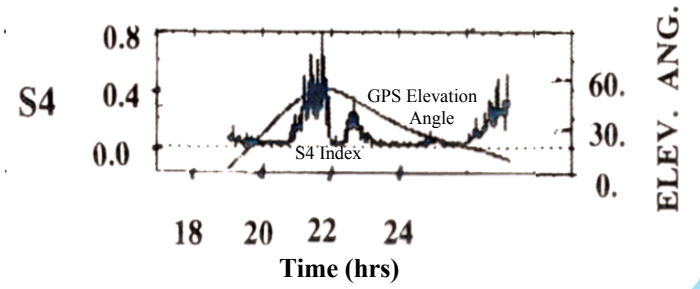
- Nightly predictions of scintillation based on ground-based ionospheric digital sounders to measure the post-sunset upward drift of the ionosphere.
- The faster the upward drift of the ionosphere, the more likely scintillation will occur.

Product:

- The S4 index - a measure of scintillation activity
- Presented as **Red**-**Yellow**-**Green** Alert/Warning







WHAT NASA CAN PROVIDE

- **Satellites in equatorial, C/NOFS (Communication/Navigation Outage Forecast System) type orbits, with sensors to understand, specify and forecast, at all longitudes, ionospheric scintillation activity**
- **COSMIC-type GPS receivers in Low Earth Orbit (LEO) providing near real-time electron density profiles, globally, for ionospheric data assimilation models**
- **Critical ionospheric observations for model validation**

WHAT LWS SHOULD PROVIDE

- Provide state-of-the-art assimilation models with sufficient, near real-time data from sensors such as ionospheric imagers and COSMIC-type GPS receivers

- Development of a global, ionospheric **TEST-BED** model capable of **SIMULATING** ground-based and satellite-borne sensor observations for all levels of geomagnetic and solar activity conditions