

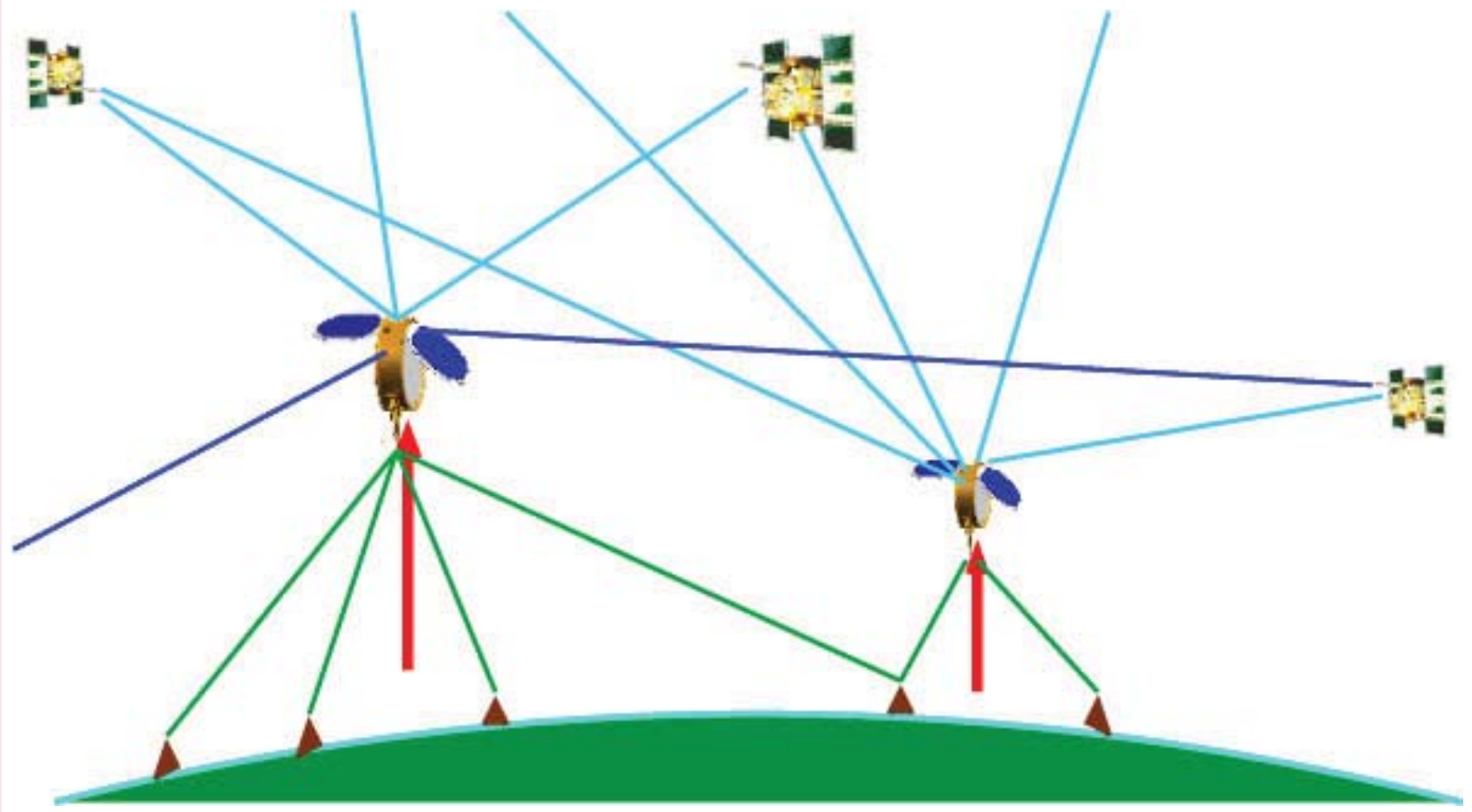
Status and Plans at CDAAC for Providing Near Real-time Ionospheric Data Products from COSMIC

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COSMIC Ionospheric Measurements

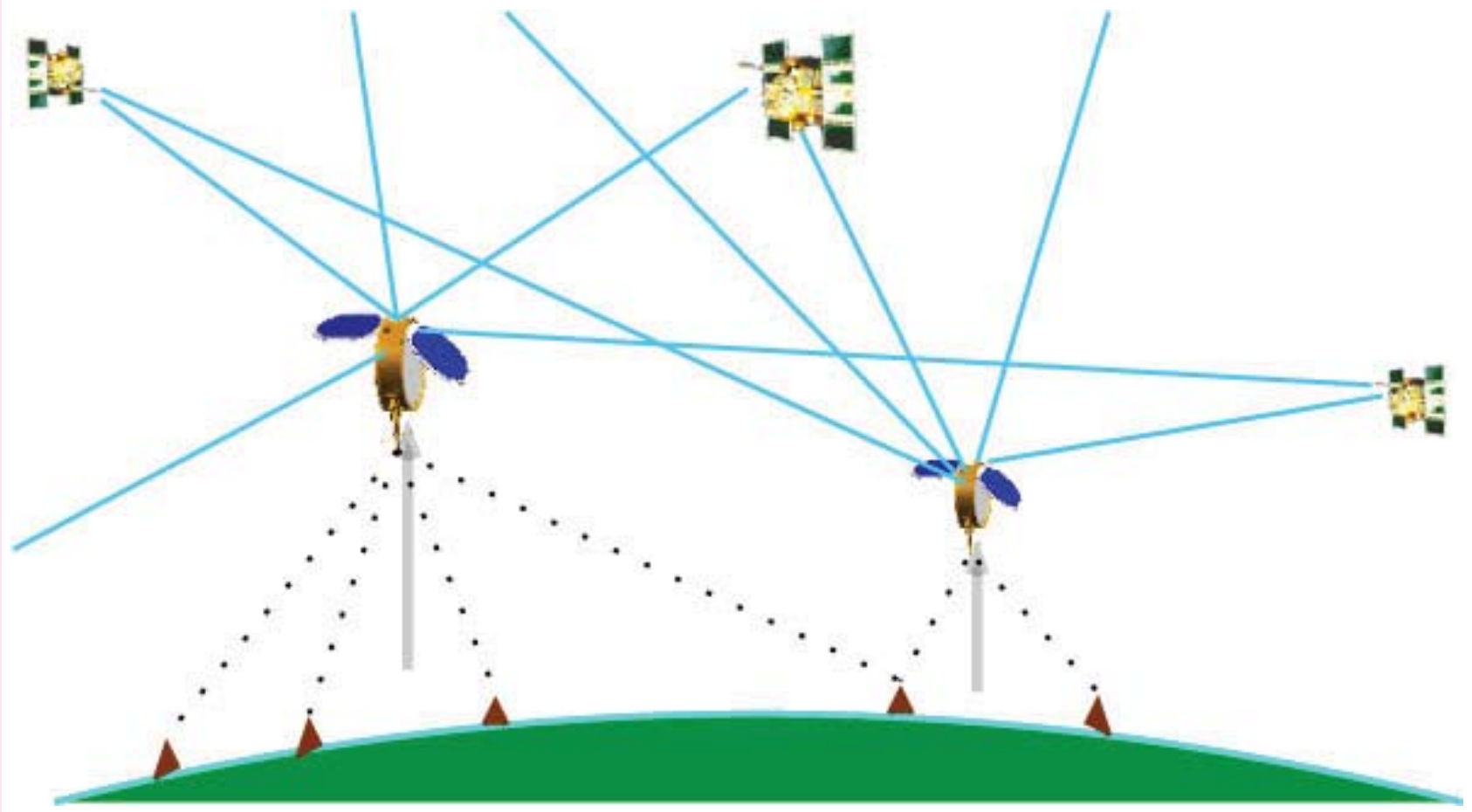


GPS receiver: { Total Electron Content (TEC) to all GPS satellites in view
Ionospheric radio occultations (profiles) & scintillations

Tiny Ionospheric Photometer (TIP): Ultra-violet emission from ionosphere

Tri-Band Beacon (TBB): TEC & scintillations on satellite-to-ground links

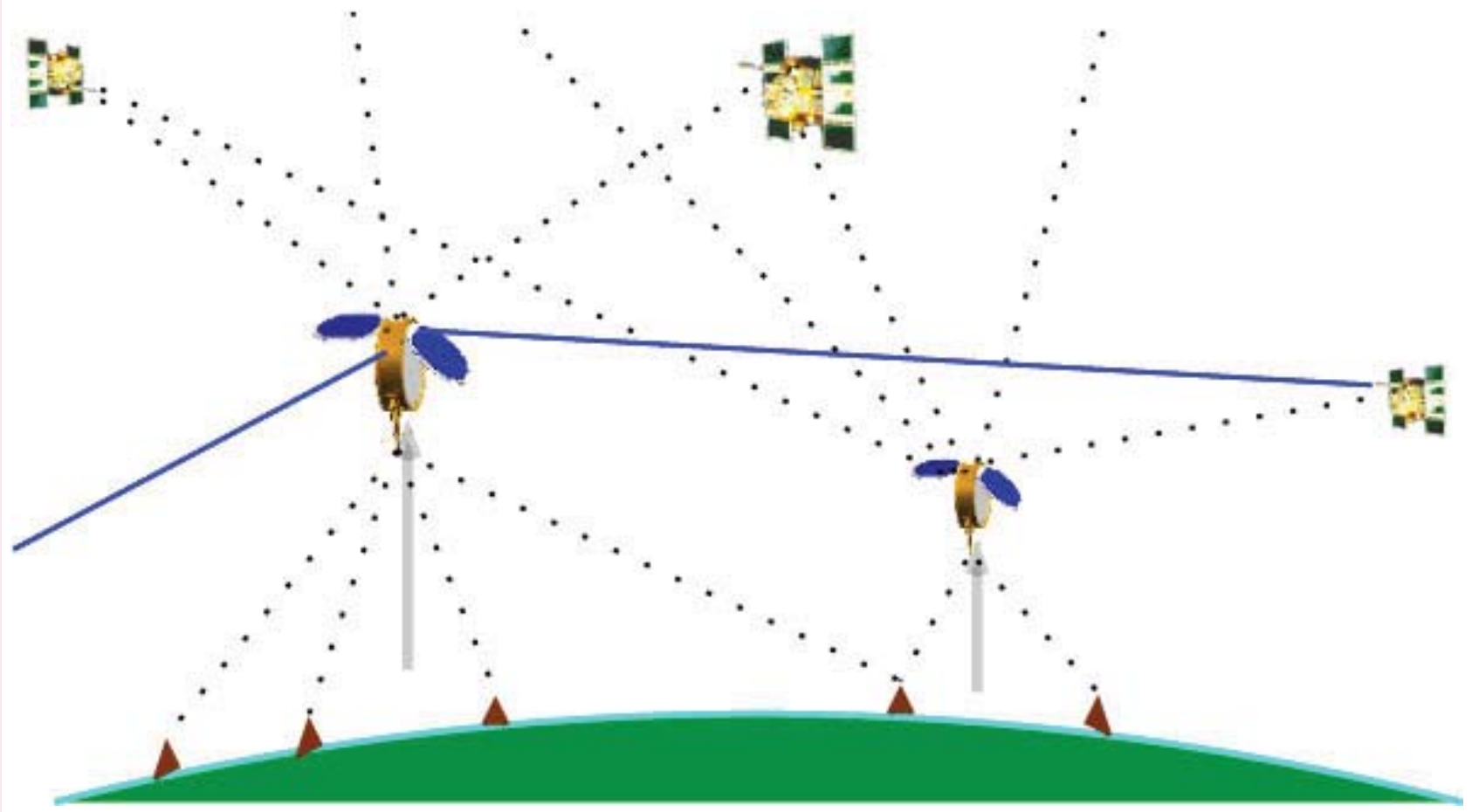
COSMIC Ionospheric Measurements



Total Electron Content measurements:

- High-resolution (1 Hz) TEC to all GPS satellites in view at all times
- Can track up to 12 GPS satellites at the same time (9 aft + 4 fore)
- Useful for global ionospheric tomography and data assimilation

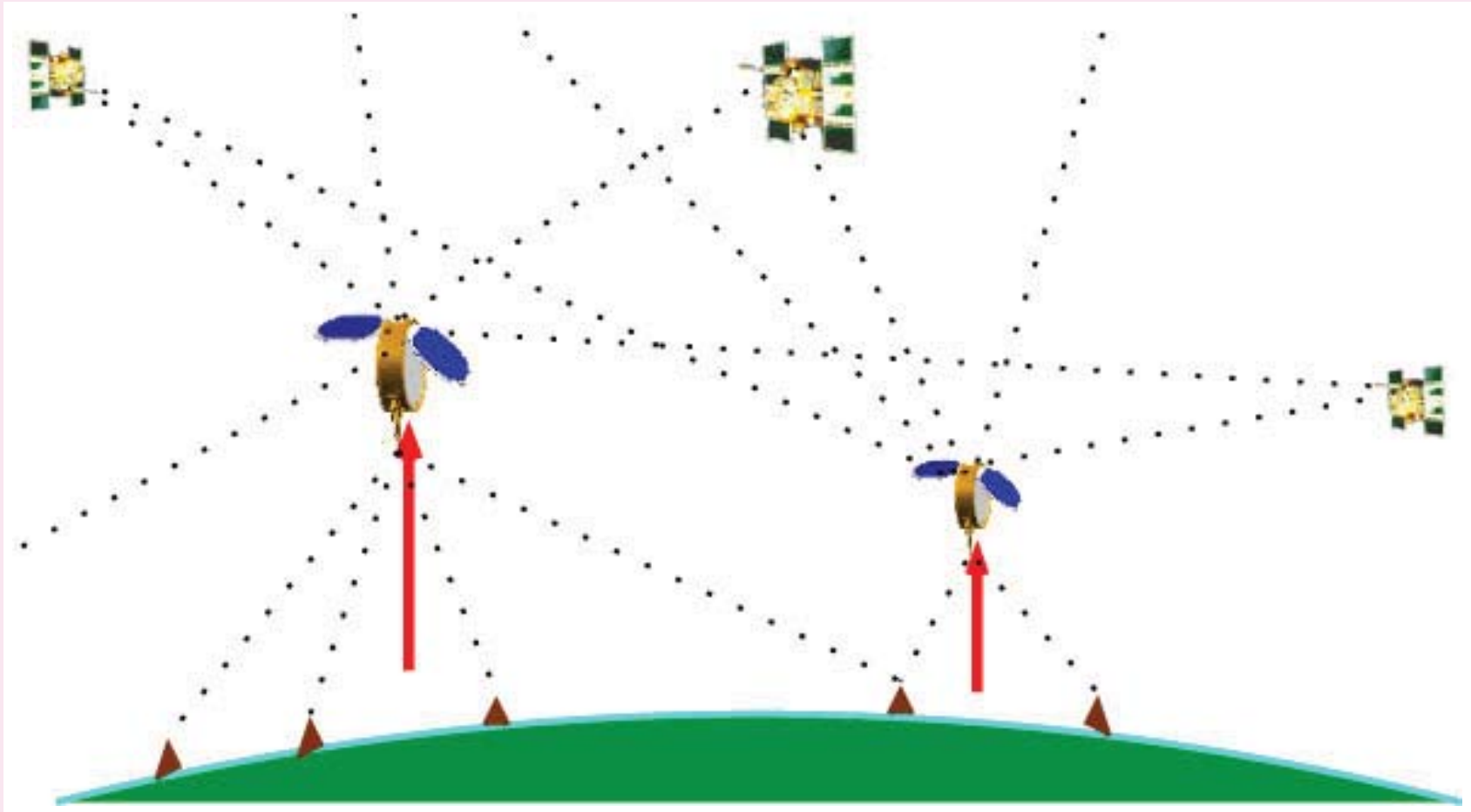
COSMIC Ionospheric Measurements



Ionospheric GPS occultation measurements:

- High-resolution (1 Hz) occultation TEC below orbit altitude
- Ionospheric electron density profiles from orbit altitude and down
- Ionospheric scintillations using the two limb antennas (50 Hz)

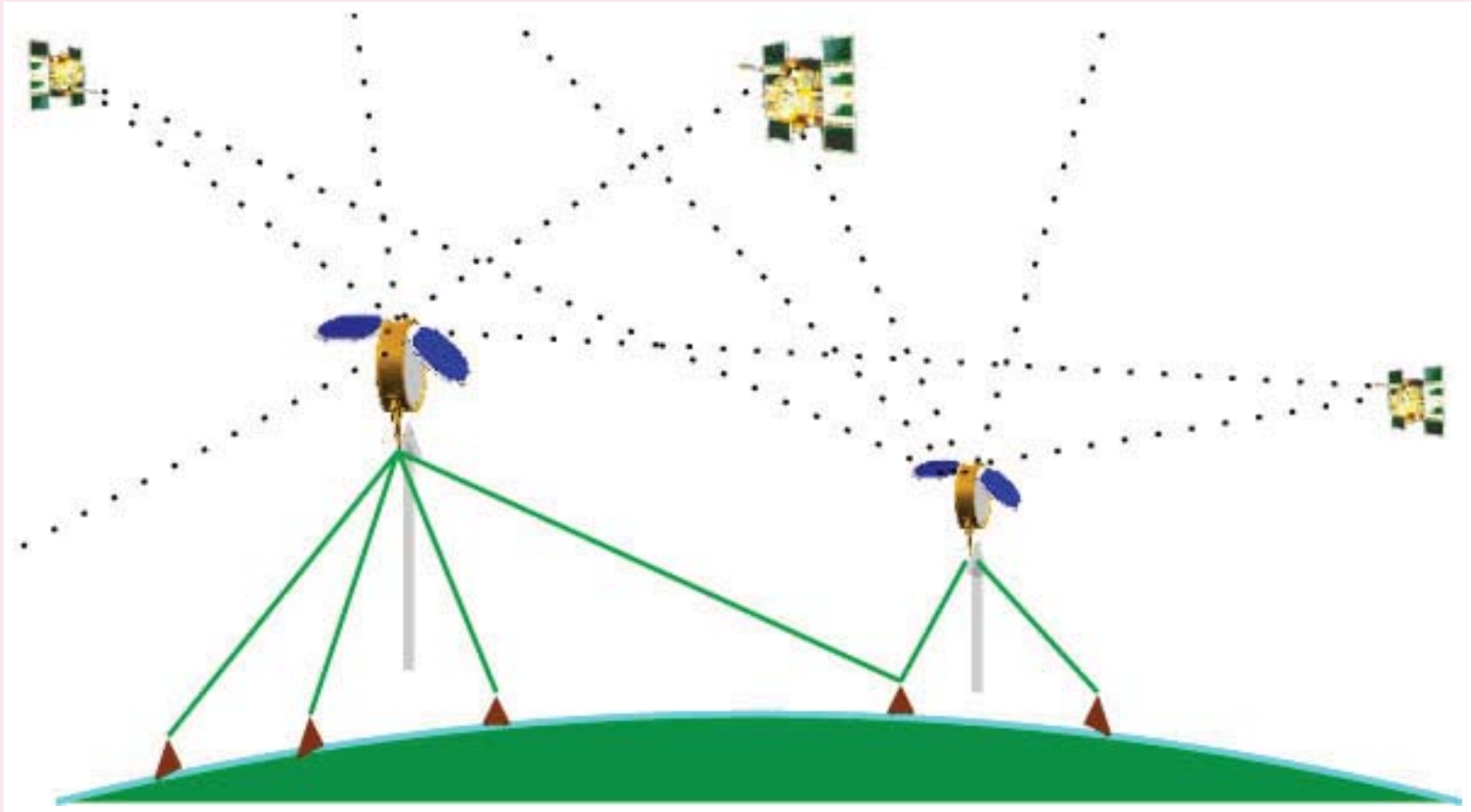
COSMIC Ionospheric Measurements



Tiny Ionospheric Photometer measurements:

- Emission (1356 Å) due to recombination of oxygen ions and electrons
- Nadir intensity along sub-satellite track – proportional to $\int N_e^2 dz$
- High quality data on night-side – uncertainty about day-side quality

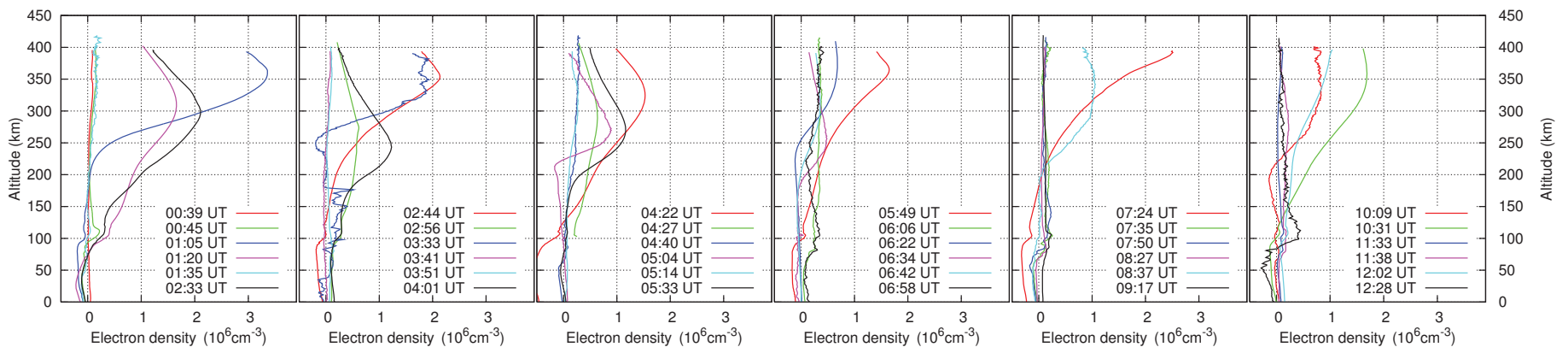
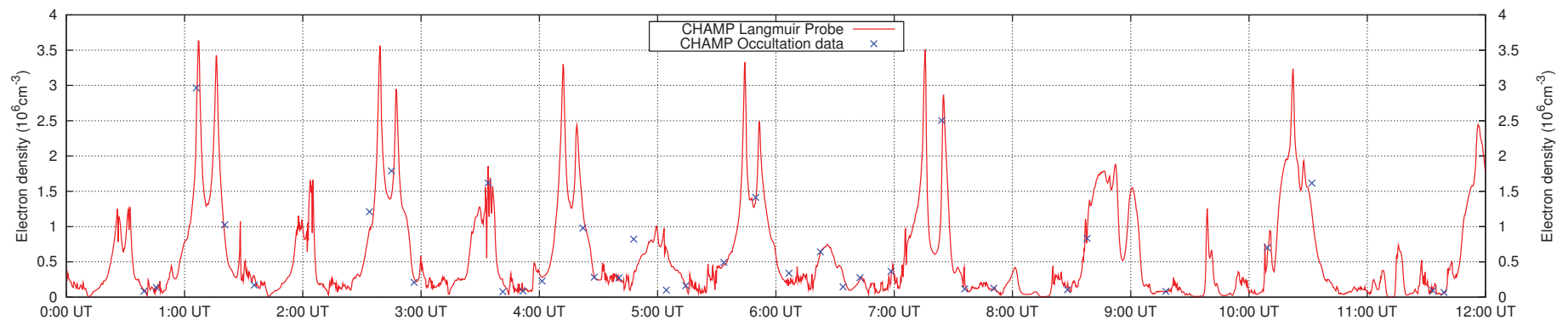
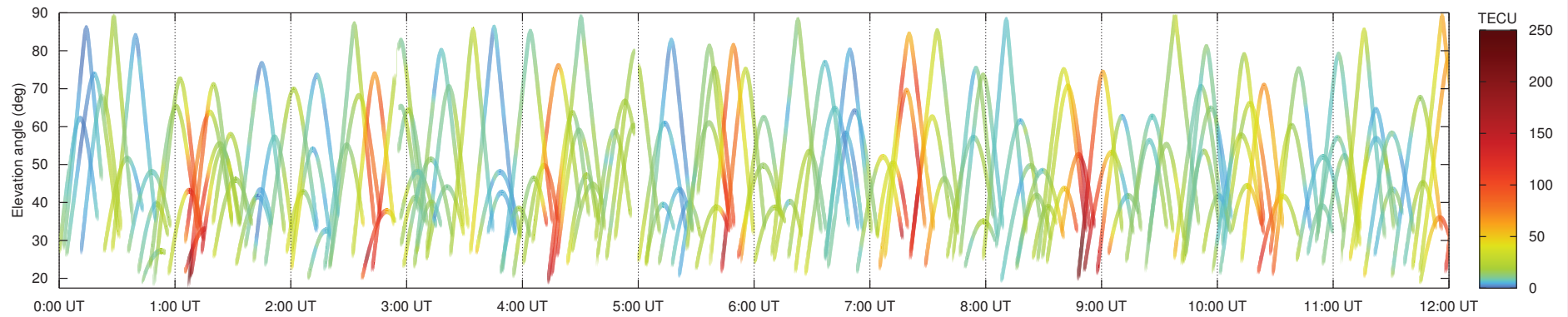
COSMIC Ionospheric Measurements



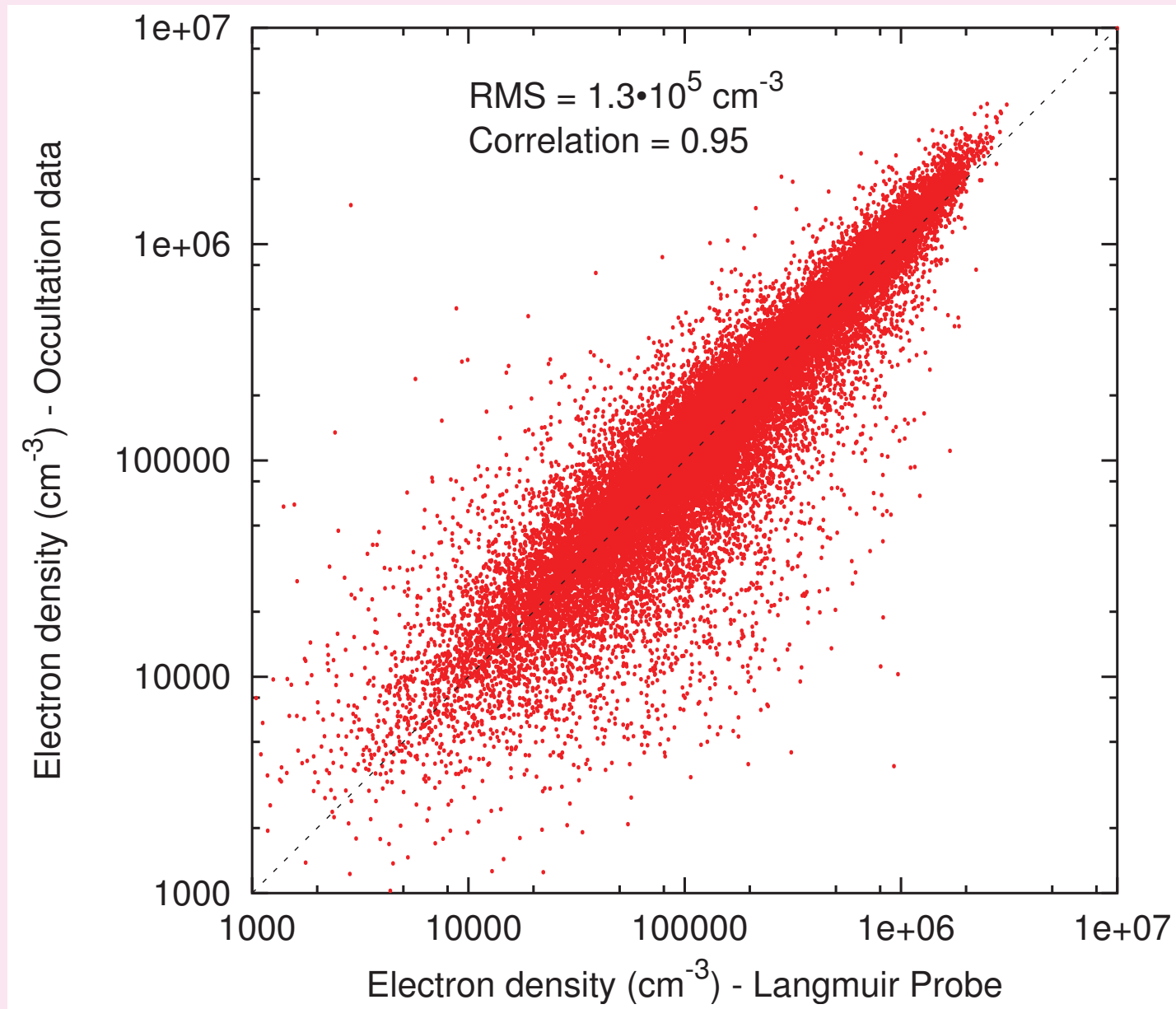
Tri-Band Beacon measurements:

- Radio signals transmitted from COSMIC at 150, 400, and 1067 MHz
- TEC between the COSMIC satellites and chains of ground receivers
- Amplitude and phase scintillations on the satellite-to-ground links

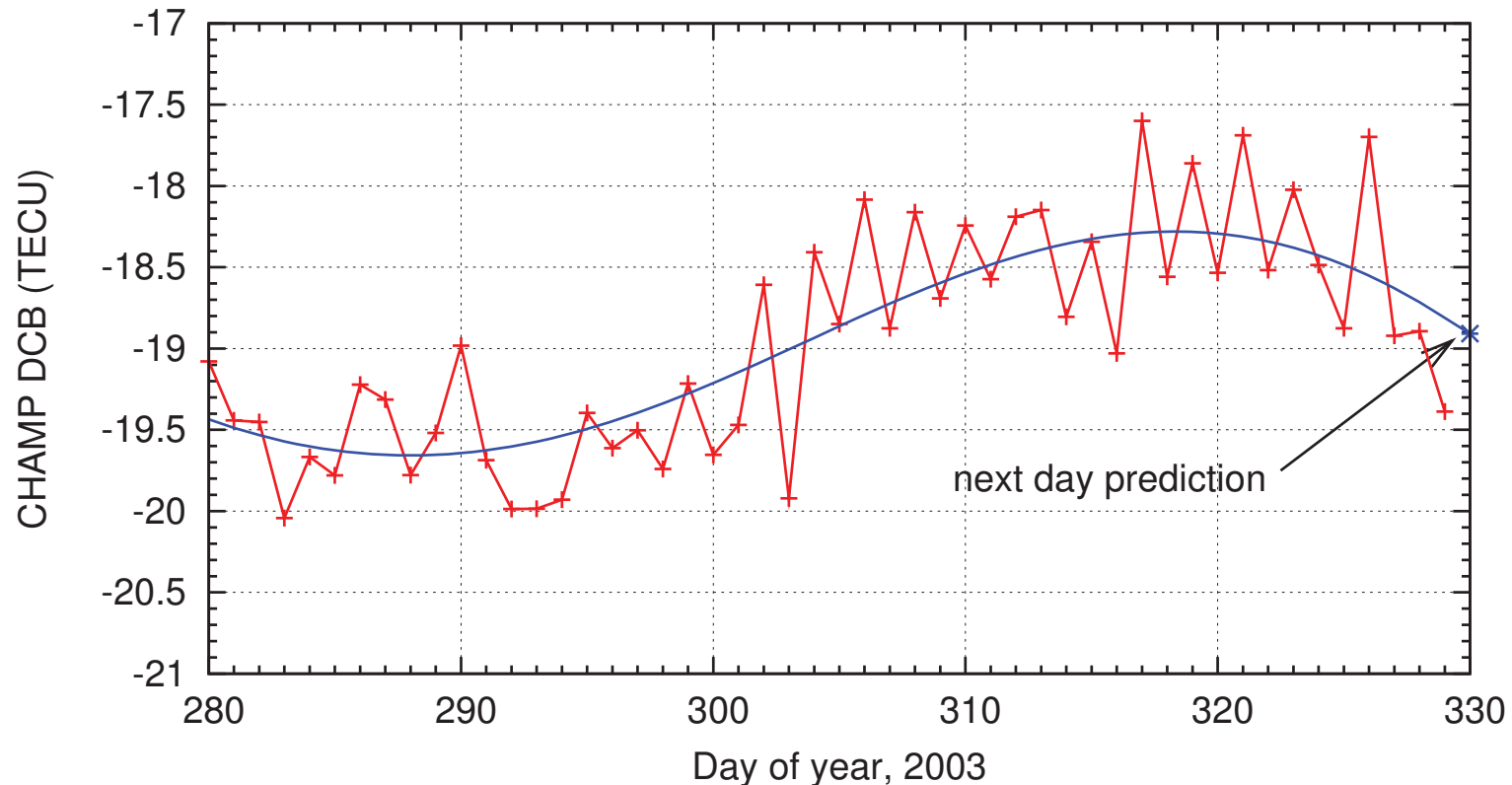
Ionospheric Data from CHAMP, Oct 29 2003



16 Months of Data – 44 000 Comparisons

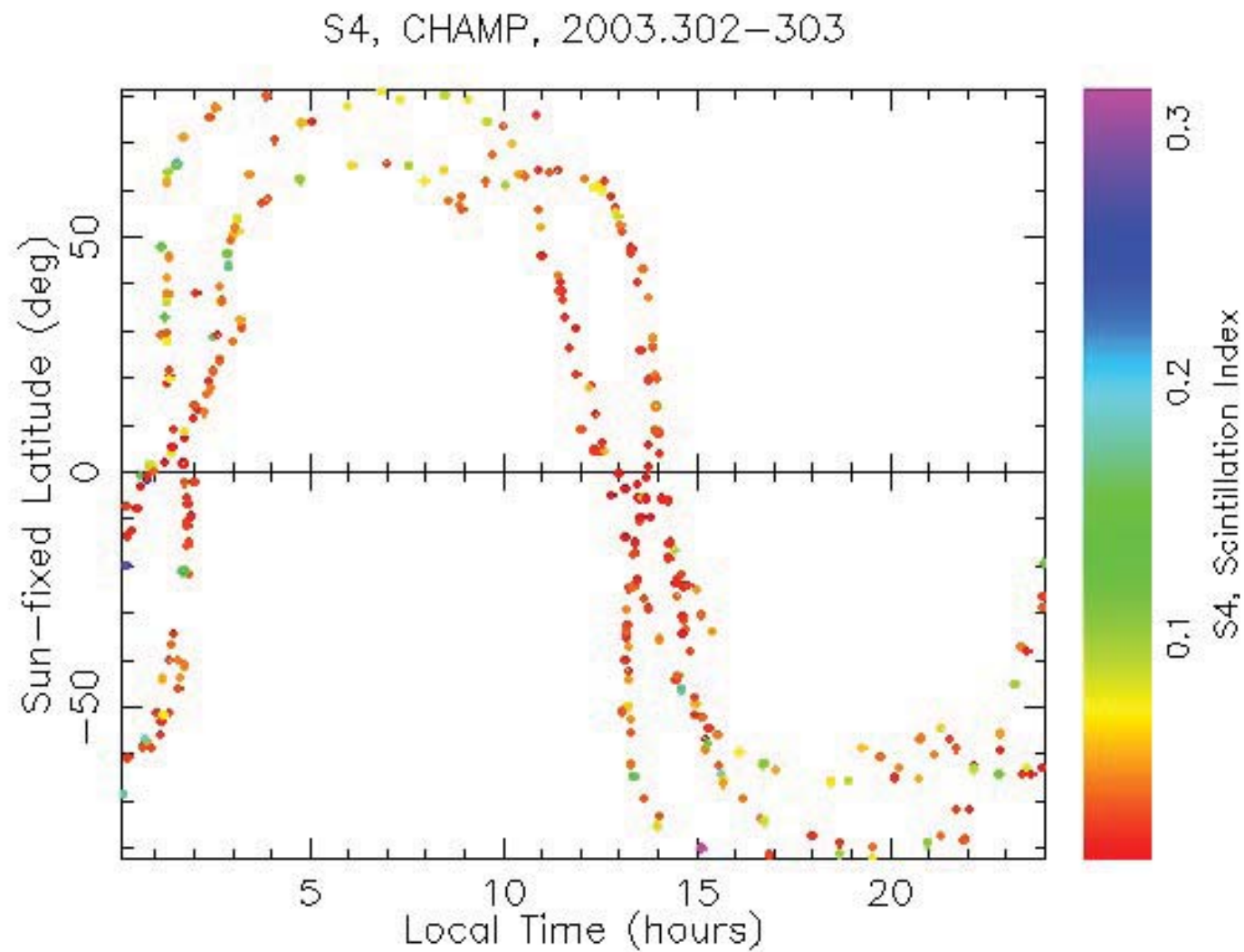


CHAMP Differential Code Bias



- Based on simple assumptions (e.g., azimuthal symmetry above LEO)
- Single day estimates based on 24 hr average – next day prediction (for near real-time processing) based on smoothing over 50 days
- For COSMIC there will be 6×2 DCBs to solve for

CHAMP Ionospheric Scintillation Map



Status and Plans for COSMIC

Total Electron Content measurements

Plans: Quality control, outlier detection, cycle-slip correction, and Differential Code Bias calibration

Status: Prototype working for CHAMP data – not yet integrated in CDAAC processing system

Ionospheric GPS occultation measurements

Plans: Reducing effects from horizontal gradients in profile retrievals using a model (e.g., GAIM)

Status: Profiles derived via Abel inversion ●● Scintillation maps not yet integrated in CDAAC system

Tiny Ionospheric Photometer measurements

Plans: Providing radiances derived from raw data (counts) as well as pointing direction ●● Combining TIP data and GPS occultation data for “in-plane” occultations (Naval Research Lab)

Status: Work on radiance retrieval codes (in collaboration with NRL) in progress

Tri-Band Beacon measurements

Plans: Plans regarding processing of TBB data are not in place ●● One TBB receiver may be installed on the top of the roof at UCAR – CDAAC will process data from this one

Status: Ongoing work to install receiver chains in various countries all over the world (NRL)

COSMIC Data Products and Formats

Data description	Level/Type	Main products	Resolution	Format	Latency
GPS receiver data from the POD antennas – one file per COSMIC POD antenna per dump	level 1a. podGps	- time - phases - pseudo-ranges - SNRs	temporal: 1 sec	RINEX	$\lesssim$ 115 min
LEO attitude and orbits (from real time navigation solutions) – one file per COSMIC satellite per dump	level 1a. leoAtt	- time - attitude param. - position - velocity	temporal: 10 sec	ASCII	$\lesssim$ 115 min
Precise LEO orbits – one file per COSMIC satellite per dump	level 1b leoOrb	- time - position - velocity	temporal: 1 min	SP3	$\lesssim$ 145 min
IGS Ultra-Rapid GPS orbits (including 24hr predicted orbits) – one file every 6hr	level 1a. gpsOrb	- time - position - velocity	temporal: 15 min	SP3	0 min
Absolute TEC to all GPS satellites in view (QC and bias resolved) – one file per COSMIC satellite per GPS satellite per arc	level 1b ionTec	- time - Rx & Tx pos. - absolute TEC - code biases	temporal: 1 sec	NetCDF	$\lesssim$ 115 min
Ionospheric occultation excess phases and amplitudes – one file per GPS occultation	level 1b ionPhs	- time - SNRs - Rx & Tx pos. - Rx & Tx vel. - excess phases	temporal: 1 sec	NetCDF	$\lesssim$ 145 min
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Summary

- Three instruments on board each COSMIC satellite will provide ionospheric data:
 - GPS receiver: TEC, electron density profiles, and scintillations
 - TIP: Nadir intensity from radiative recombination emission along the sub-satellite track
 - TBB: TEC and scintillations on satellite-to-ground links
- COSMIC will provide an unprecedented large amount of ionospheric data useful for data assimilation into space weather models and ionospheric research in general
- Feedback very welcome on planned near real-time ionospheric data products and formats
- We also need to discuss ionospheric data distribution...