



SoG additions:

Radiation dose & Thermosphere

David Jackson

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Radiation Dose Rate: Observation Requirements

Requirement	Layer	Uncertainty	Hor. res.	Vert. res.	Obs cycle	Timeline
Goal	LS	5%	100 km	0.1 km	60 sec	5 min
Threshold	"	20%	500 km	2 km	10 min	20 min



Radiation Dose: Techniques

- dosimeters that are carried on board
- TEPCs too heavy (5-10 kg)
- Compact solid-state (CREAM + follow – ons)
 - 260 x 107 x 57 mm and weighs 1.16 kg
 - even more miniaturised instrument being developed with a target mass of less than 250 g excluding batteries
 - flown on test flights



Radiation Dose: Meets reqs?

- Uncertainty - meets threshold
- Hor. res. - **threshold not met**
- Vert. res. - close to goal
- Obs cycle - between goal and threshold
- Timeliness – better than goal



Radiation Dose: Recommendations

- Efforts should be made to install radiation monitors on aircraft. UK RAE recommends all aircraft operating above a certain altitude (25000-35000 feet) should carry a radiation sensor and logger.
- Examination should be made of the most effective means of disseminating on-board radiation monitor observations in NRT (e.g. using AMDAR), with a view to a potential trial/demonstration



Thermosphere: Observation Requirements

Variable	Layer	Req	Uncertainty	Hor. res.	Vert. res.	Obs cycle	Timeliness
Atmos. density	LoTherm	Goal	5%	100 km	5 km	5 sec	5 min
		Threshold	10%	500 km	25 km	5 min	60 min
	HiTherm	Goal	10%	100 km	20 km	5 sec	30 min
		Threshold	20%	500 km	100 km	30 min	60 min
Horiz. wind	LoTherm	Goal	5 m/s	100 km	5 km	5 sec	5 min
		Threshold	10 m/s	500 km	25 km	5 min	60 min
	HiTherm	Goal	10 m/s	100 km	20 km	5 sec	30 min
		Threshold	30 m/s	500 km	50 km	30 min	60 min
Atmos. T	LoTherm	Goal	10 K	100 km	5 km	5 sec	5 min
		Threshold	20 K	500 km	25 km	5 min	60 min
	HiTherm	Goal	35 K	100 km	20 km	5 sec	30 min
		Threshold	140 K	500 km	50 km	30 min	60 min



Thermospheric Temperature: Techniques

- Satellites - focus on emission from the diatomic oxygen atmospheric band (A-band)
 - OSIRIS up to 110 km
- FPIs - the atomic oxygen 630 nm red line emission. Limited to nighttime and clear sky conditions at present. T near 250 km
- Lower thermospheric temperature can also be observed by rockets
 - Infrequent and expensive



Thermospheric Temperature: Meets reqs?

- Uncertainty - meets / exceeds goal (OSIRIS, FPI)
- Hor. res. - better than threshold (OSIRIS)
- Vert. res. - **meets goal (OSIRIS) but only up to 110km**
- Obs cycle - better than threshold (OSIRIS); exceed goal (FPI)
- Timeliness – **assumed to not meet threshold**



Thermospheric Density: Techniques

- LEO accelerometers
 - CHAMP, GOCE, GRACE ended but SWARM and GRACE follow-on
- Mean density from radars, TLE
- Tracking geodetic satellites
- Satellite Limb sounding
 - GUVI not now operational
 - SSULI and SSUSI flying – products in development



Thermospheric Density : Meets reqs?

- Uncertainty - meets threshold and goal met in most cases (accelerometer, TLE / radar)
- Hor. res. - goal met (along track)
- Vert. res. - approx. meets threshold (accelerometer, TLE / radar)
- Obs cycle - close to goal (accelerometer); not met (mean densities)
- Timeliness – **not met**. Should be met for SWARM



Thermospheric Horizontal Wind: Techniques

- Satellite observations of the diatomic oxygen atmospheric band (A-band). Also airglow from excited states of monatomic oxygen can be used to infer upper thermospheric wind
 - TIDI from 2002-2005. MIGHTI planned.
- FPI and rockets
- derived from accelerometers



Thermospheric Horizontal Wind: Meets reqs?

- Uncertainty - meets goal (TIDI, FPI). worse than threshold (accelerometer)
- Hor. res. - threshold (MIGHTI)
- Vert. res. - meets goal (TIDI), but only up to 120 km. MIGHTI goes to 300 km
- Obs cycle - satellite data close to goal
- Timeliness – **assumed to not meet threshold**



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Thermosphere: Recommendations

- Increase observations of atmospheric density made by accelerometers. Future data to be delivered with low latency.
- Maintain / increase limb satellite observations of density (e.g. SSULI) for operational use. Deliver OSIRIS lower thermosphere T obs in NRT?
- Further develop inference of winds from accelerometer. Cross-calibration with FPIs. Revisit Doppler interferometry techniques (as used in TIDI)
- Develop operational aspects of FPIs to support provision of space weather services (eg continuous operation, NRT dissemination)



Questions?