



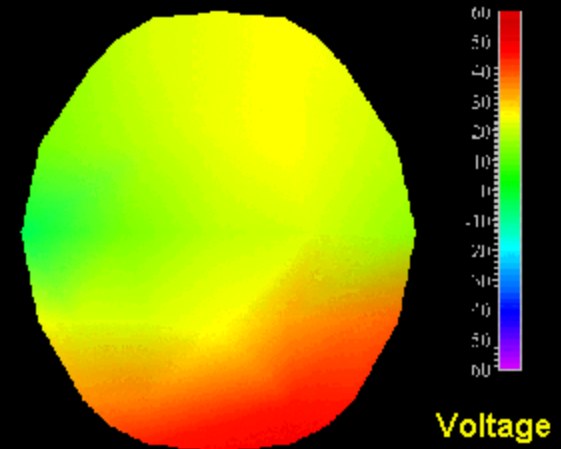
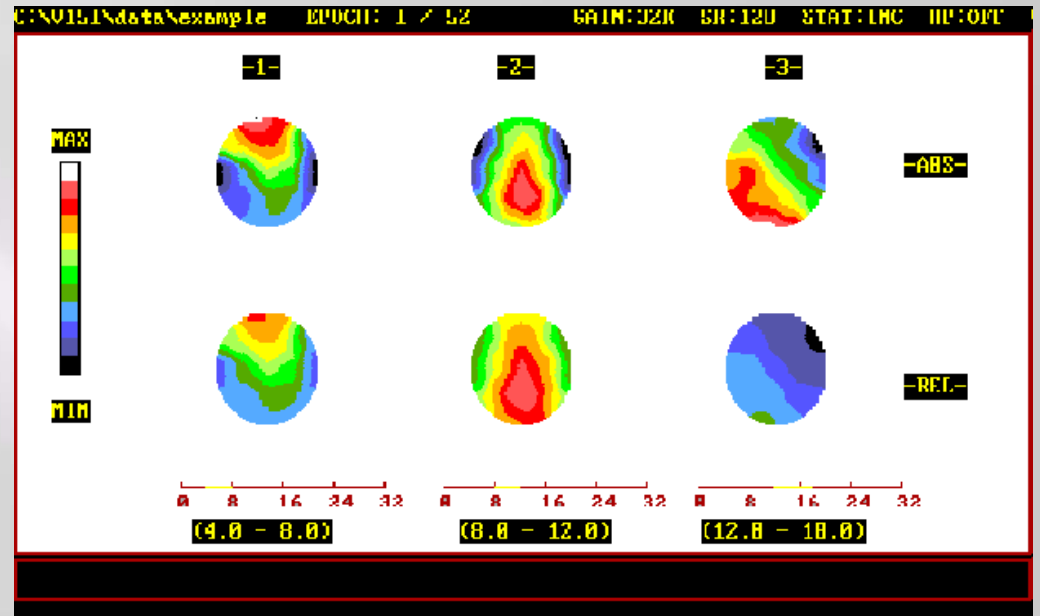
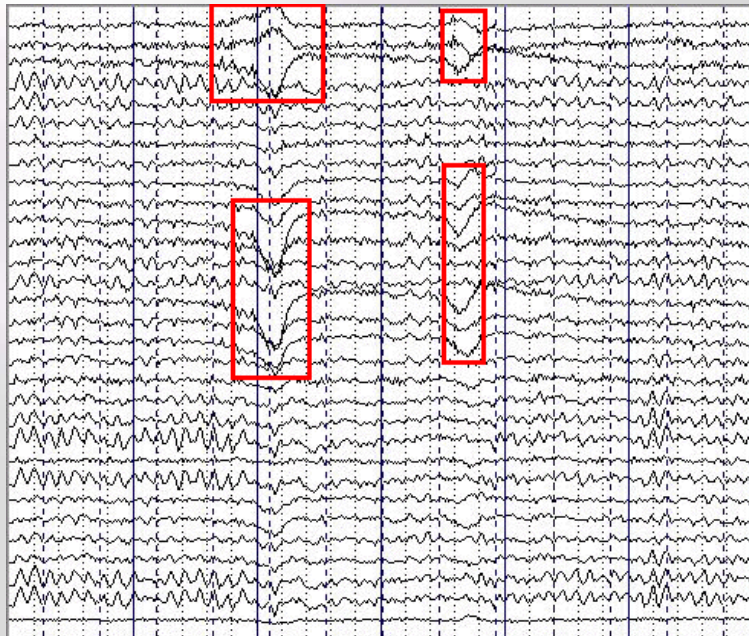
OPERATIONAL SPACE WEATHER NEEDS

John R. Allen, NASA/SOMD

CCMC Workshop
Key Largo, FL
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Pop Quiz





Lessons Learned This Week

- ▣ Stove pipes exist in the government
- ▣ I was not the first one to think of collaboration
- ▣ Ray: black box may not be a good thing
- ▣ Delores: ready to enroll in your course
- ▣ Modeling has nothing to do with airplane glue
- ▣ Educational material can be presented too fast for very smart people
- ▣ Engineers and physicists need to remember to design with biological robots in mind as well
- ▣ Language barriers can be broken down in 1 week.



Translational Analysis

- ▣ RATSURUS
- ▣ Field Lines
- ▣ Flux
- ▣ FTE
- ▣ Plasma
- ▣ Heap Space
- ▣ Boundary
- ▣ Shock
- ▣ CME





Operational Concerns

Launch

- Communication loss (Solar Proton Event, geomagnetic storming, solar flaring)
- Launch into higher radiation environment

Nominal IVA Mission Ops

- Crew Health: minimize exposure risk
- Damage to orbital vehicles
- Extended mission lengths (Lunar, Cis-Lunar, NEO, Mars)



EVA



- Increased crew exposure
- Hardware damage
- Up to ~7 hour duration
- Possibly longer lead time to shelter (Lunar)





Operational Need

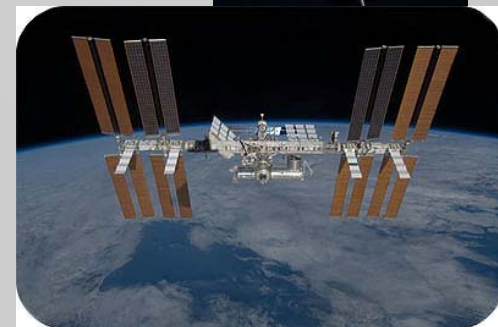
Mission Planning

- From months to over a year pre-launch
- Space weather situational awareness L-24 hours
- Second assessment made L-1 hour
- Need ability to forecast “quiet periods” from 1 to 24 hours pre-launch



Mission Ops

- Dependent on vehicle and mission length
- Dependent on mission activities (IVA versus EVA)
- Assessment of solar activity conducted L-24
- Need ability to forecast “quiet” periods from 1 to 24 hours pre-launch



ALARA – As Low As Reasonably Achievable

- Principle recognized throughout NASA’s manned spaceflight requirements
- A commitment to make all reasonable efforts to minimize exposure



Operational Support

Flight Planning

- Crew dose projections for mission duration
- Maintain space weather situational awareness

Flight Operations (since Gemini – 1962)

- 4 hour nominal daily support via JSC/Space Radiation Analysis Group (SRAG)
- 24/7/365 on-call support
- Continuous 24-hour contingency support during adverse solar activity
- Recommend actions to Flight
- Daily tag-ups with NOAA/Space Weather Prediction Center (SWPC)
- Relies on robotic observational assets at Geosynch. and in heliosphere

Risk Management / Mitigation

- Time / Distance / Shielding
- Planning / re-planning
- Manipulation of local shielding



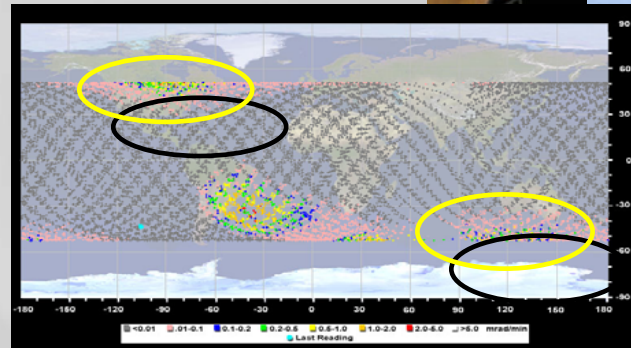
Mission Support: Current Paradigm

Situational-Awareness (nowcasting): Sun and Heliosphere

- Rely on real-time observations in heliosphere (GOES, SoHO, ACE, STEREO)
- Rely on information from NOAA/SWPC including ground-based imagery of solar disk
- Active on-board monitoring [ISS/STS Tissue Equivalent Proportional Counter (TEPC), ISS Extra-Vehicular Continuous Directional Spectrometer (EVCPS)]
- Passive on-board monitoring (crew CPDs)

Low Earth Orbit (LEO)

- Quiescent Trapped field (empirical modeling)
- SPE impact:
 - Changes in geomagnetic shielding
 - Increased dose at high latitude passes
- Phasing of vehicle orbit

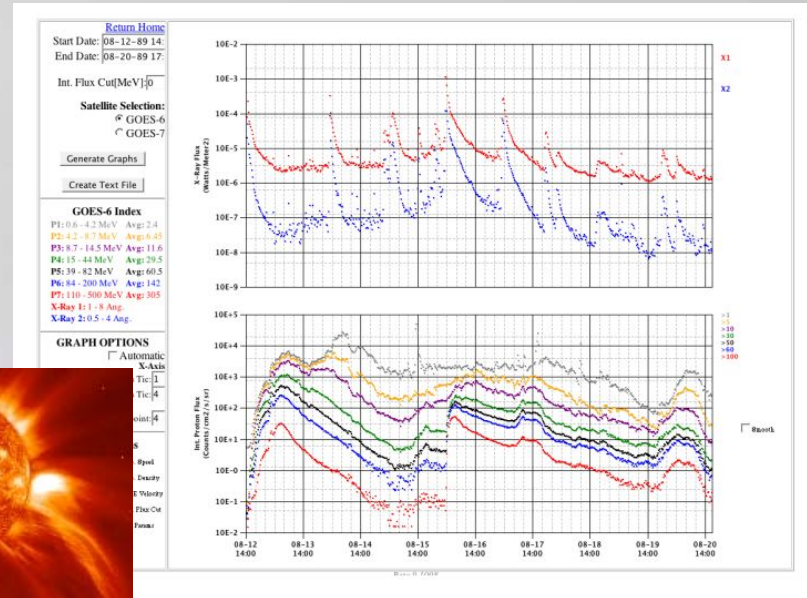
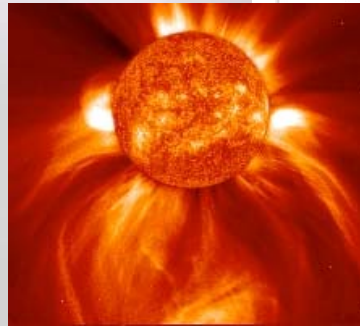




Mission Support: Future Needs

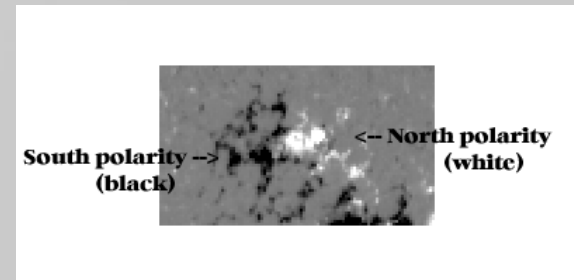
Nowcasting/Situational Awareness

- Relevant particle spectral measurements
 - 10 to 1000 MeV/nucleon
 - Near free space (L1)
 - Evolution / Temporal Profile
- Solar wind dynamics
- Interplanetary magnetic field
- Geomagnetic field
- Magnetograms
- CME imagery



Forecasting Solar Activity

- Changes in solar activity
- Solar Proton Events (Onset, Peak, Evolution/Temporal Profile)
- Need forecasts of “quiet” times out to 24 hours





Space Weather Data

Data	Use	Location
Visual (H-α, white light)	Active region character	Ground Based
Magnetometer	Geomagnetic connectivity	ACE
Solar Plasma	The changing environment	ACE
X-ray flux	First indicator of activity	GOES
Coronagraph	Character of release	SoHO
Electrons	Proton pre-cursor (forecasting)	ACE/SoHO
Protons	Direct observation – primary end point	GOES/ACE/SoHO
Magnetograms	Active Region character and evolution Proton pre-cursor (forecasting)	SoHO / SDO
EUV	Active Region character. Forward look with STEREO	SoHO / STEREO

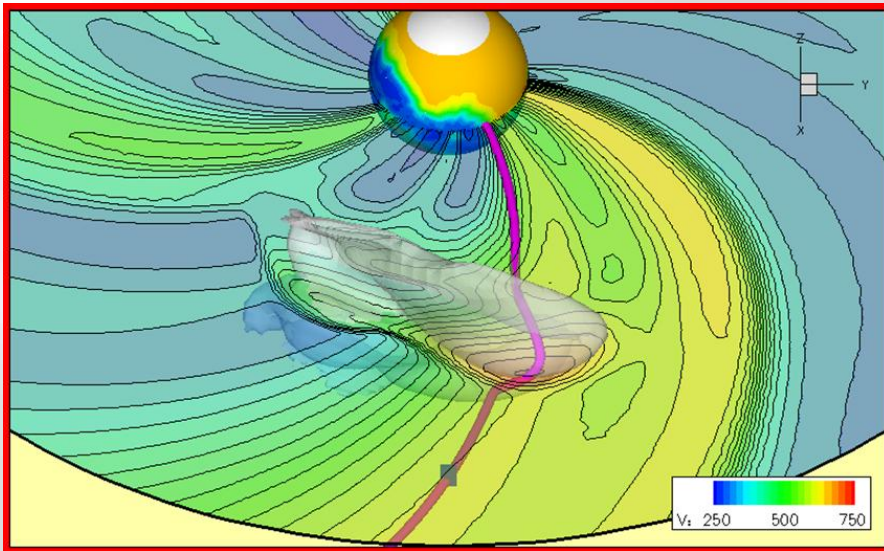


Collaboration

Robotic and manned missions share mitigation concern

- SPE Impact
- Heavily dependent on a robust research community
- Research, to understanding, to operational procedure
- Need coupled data-first principles/empirical model solutions in real time.

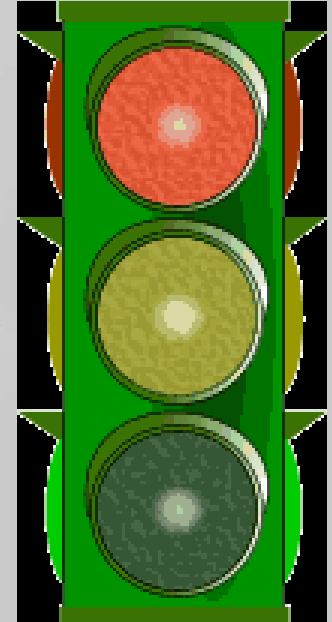
Science



Verification
Validation
Config. Manag.



Operations





Transition to Ops

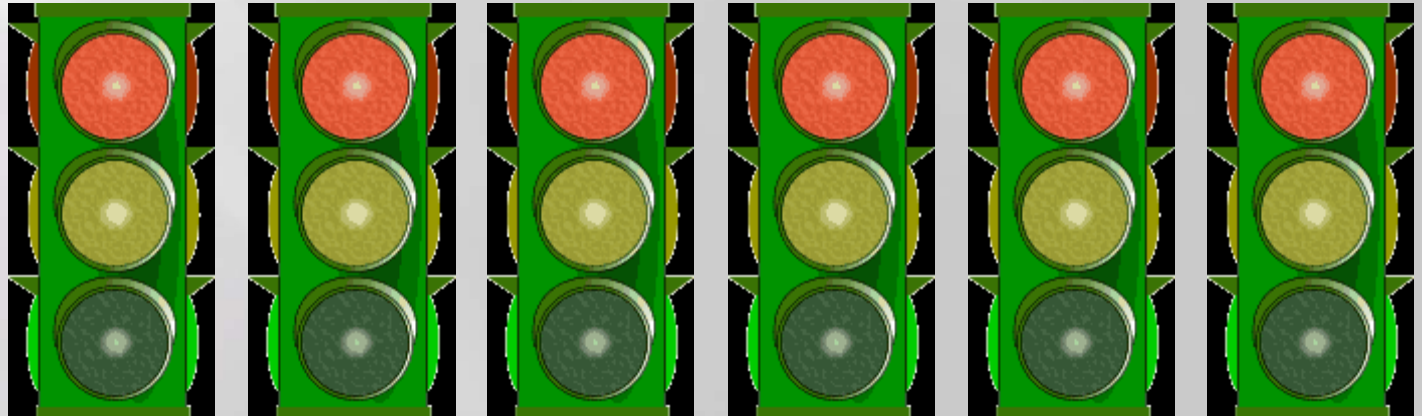
Real-time Data Streams

- Leverage agency resources to ensure data availability
- Understand science-quality and ops-quality data needs

Model Verification / Validation (V&V)

- Scientific significance somewhat different than ops utility
- V&V are typically different between science and ops
- V&V is a two step process. First scientific V&V and then operational V&V.

Optimal Operational Description





Thanks to:
Neal Zapp, Dan Fry (JSC/SRAG)

