Space Weather Models

- At or used by ESA or within ESA projects
- Important models are used elsewhere
- Models also subject to ISO Standardisation process

Engineering Models of the Space Environment

- See ECSS-E-10-04 Standard on Space Environment (see Spenvis)
- Spenvis (www.spenvis.oma.be/spenvis) was established to collect and promote models, tools, data and standard methods
  - Radiation belt (AE8,AP8 CRRESELE,CRRESPRO, SAMPEX,…)
  - solar energetic particles (JPL, MSU,…)
  - cosmic rays - CRÈME, MSU
  - charging tools use analytic (e.g. Maxwellian) environments
  - atmosphere MSIS
  - ionosphere IRI

Space Weather and Orbit Determination / Mission Analysis

- Main problem is atmospheric modification due to solar & geomagnetic events
- ESA-ESOC perform orbit analysis based on MSIS (=COSPAR International Reference) model, using F10.7 and Ap (running means and daily) as “proxies” (eventually E10.7)
- Also use a CTIM thermospheric wind model (needs space weather input)
- important for
  - precise orbit determination (e.g. EO missions)
  - prediction of re-entry (e.g. MIR, Skylab,…)
  - space debris population studies
- ESOC provides a “space weather prediction service” based on BGS developed prediction software (e.g. service to Russians for MIR, others...)

Also at ESOC:

- ESOC is responsible for logging anomalies and so interested in automatic warning systems related to space weather hazards[A.Donati/ESOC]]
- ESOC participation in IGS Ionospheric Model development (for ground station applications) [J.Feltens/ESOC]

Ionospheric Models

- IRI - general purpose ionospheric model
- for propagation work (B. Arbesser-Rastburg):
  - NeQuick - derived from COSTprof - profile
  - Bent (1972) - basis for GPS- thin shell
  - COSTprof - from COST 251 project -profile
- all need SSN or F10.7
- all are weak in auroral conditions

Custom models

- XMM “medium energy particle” analysis - based on readily available satellite data ACE, IMP, Equator-S,…
- SEDAT tools can use data to construct “custom models”

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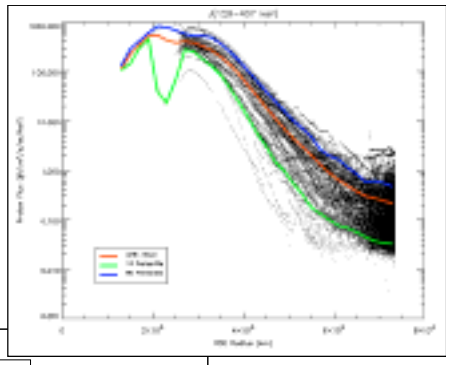

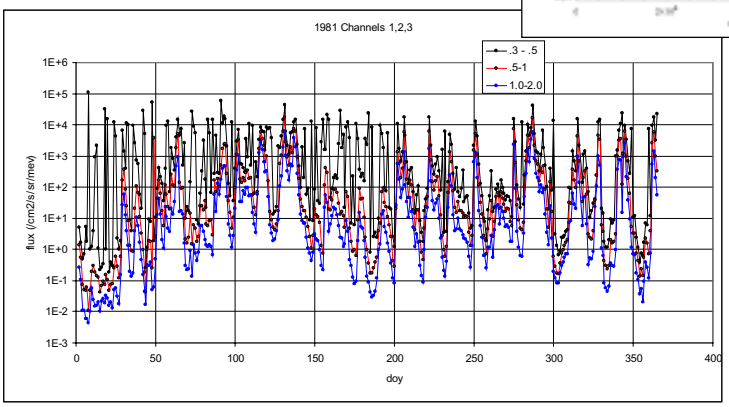

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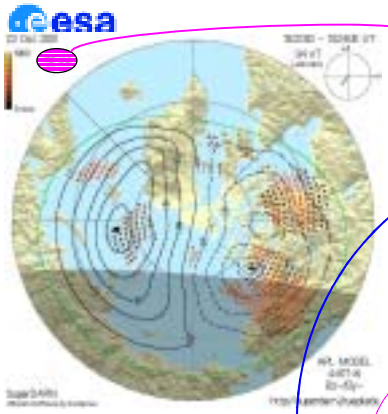
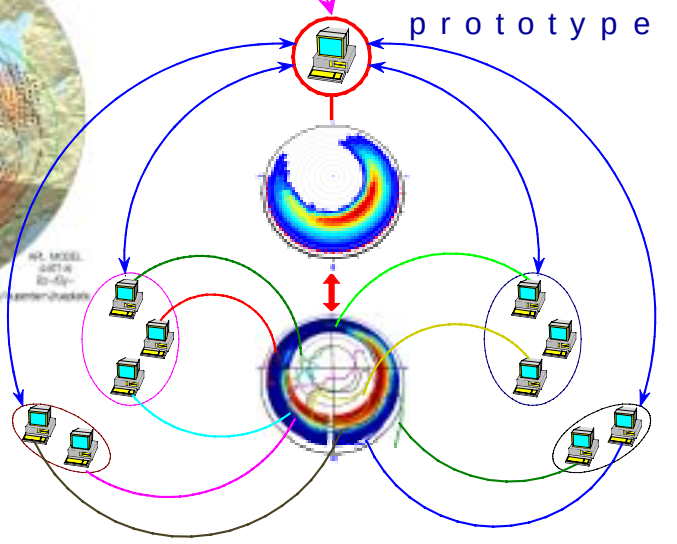


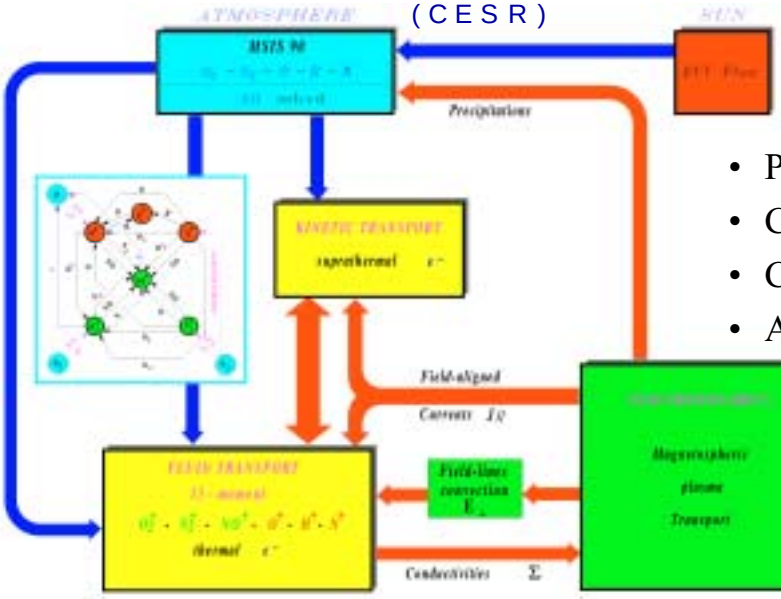


- Adequation
- Redundancy
- Robustness

$\Rightarrow$ good test

esa

Ionospheric dynamic physical model (CESR)



- Population
- Complexity
- Couplings
- Algorithms