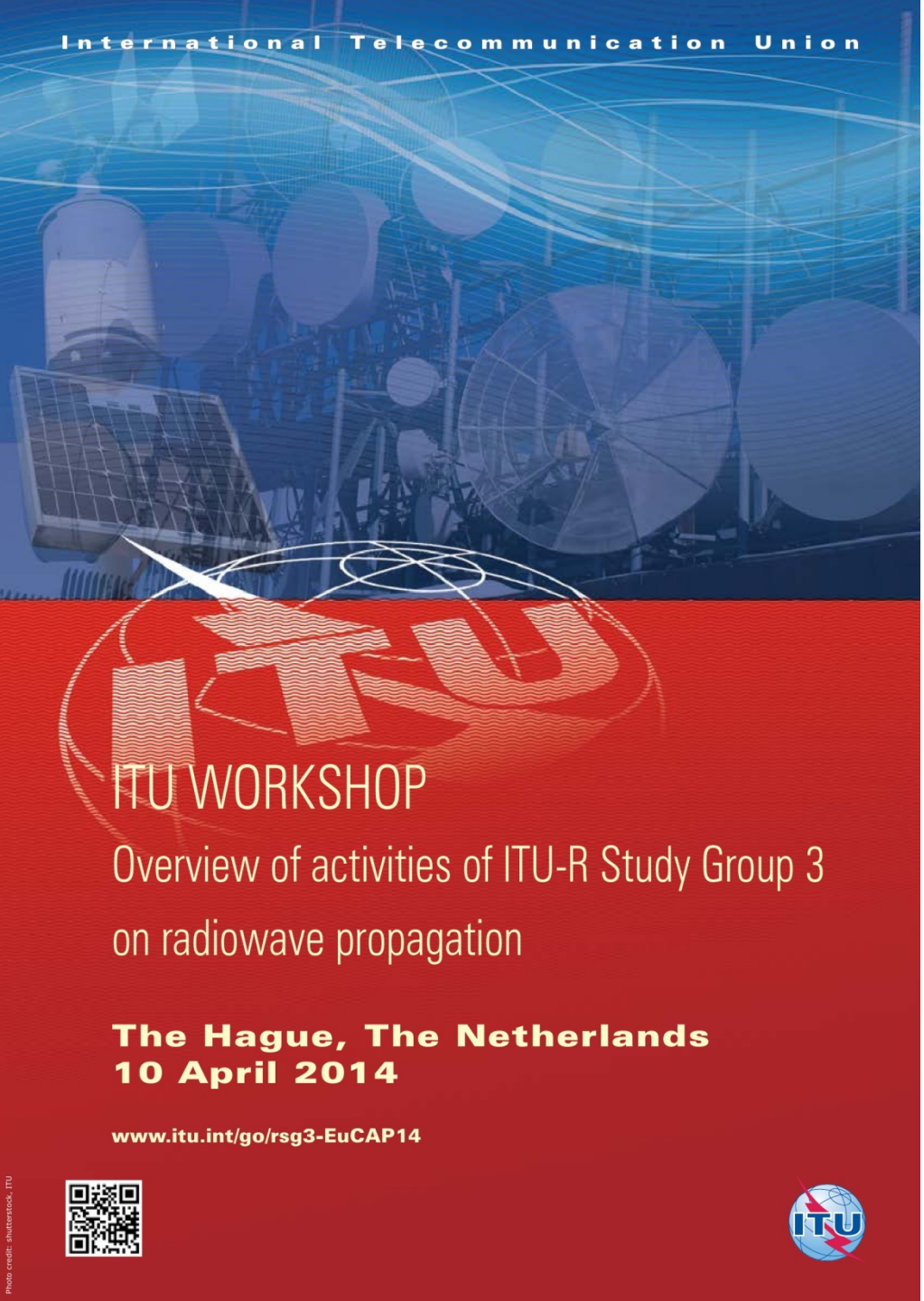
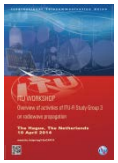


ITU WORKSHOP
Overview of activities of ITU-R
Study Group 3 on radiowave propagation:
(The Hague, 10 April 2014)

SG3 Software, Databanks and Testing Procedures

Antonio Martellucci
Carlo Riva

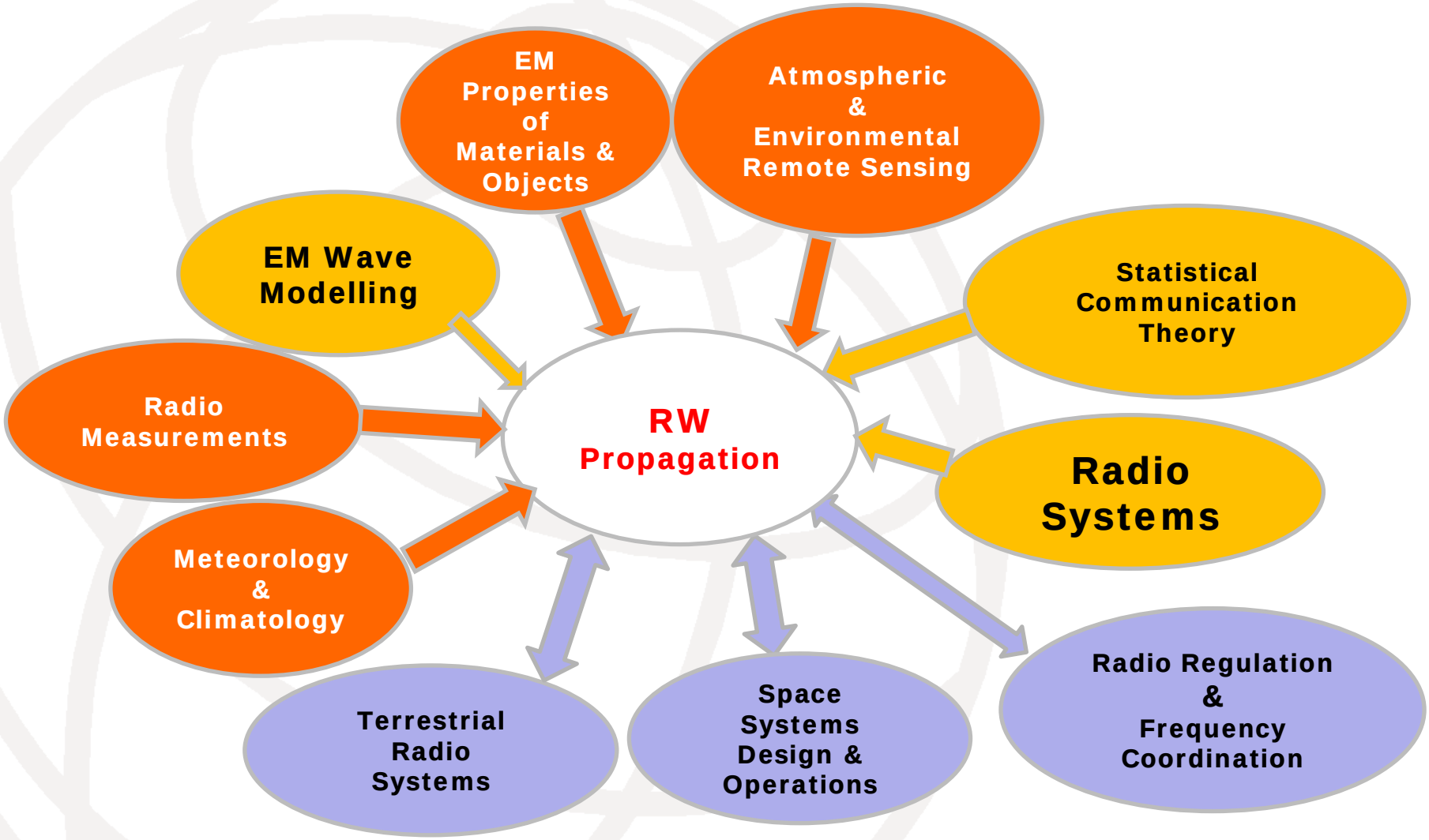


Summary

- Introduction and Background
- Terms of Reference, Work Method
- Experimental Data
- Testing of Models
- Conclusions, The way ahead

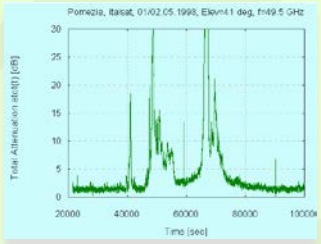
Introduction and Background

Where we are. 3M4



Introduction and Background

Example: workflow for tropospheric propagation



Meteo
Remote Sensing
Propag. Measur.
Num Weather Prod

Databases of
climatic parameters

Testing

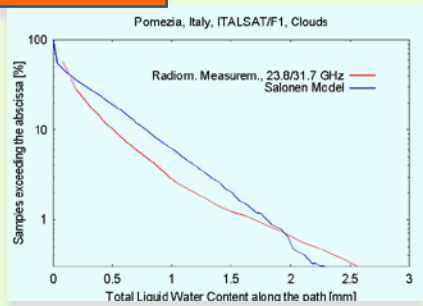
Calibr./Validat.

Modelling

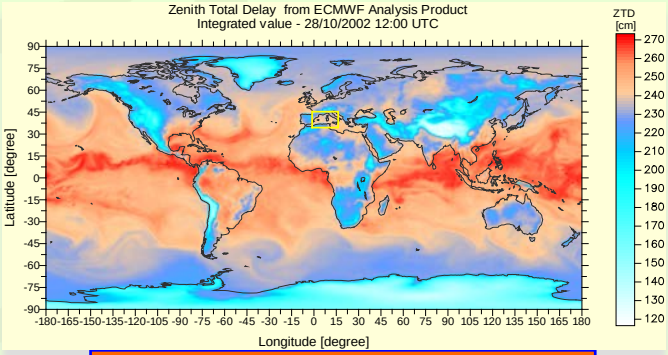
Data Analysis

$\Pr(a > A) = \ldots\ldots ?$

Models
statistical & physical



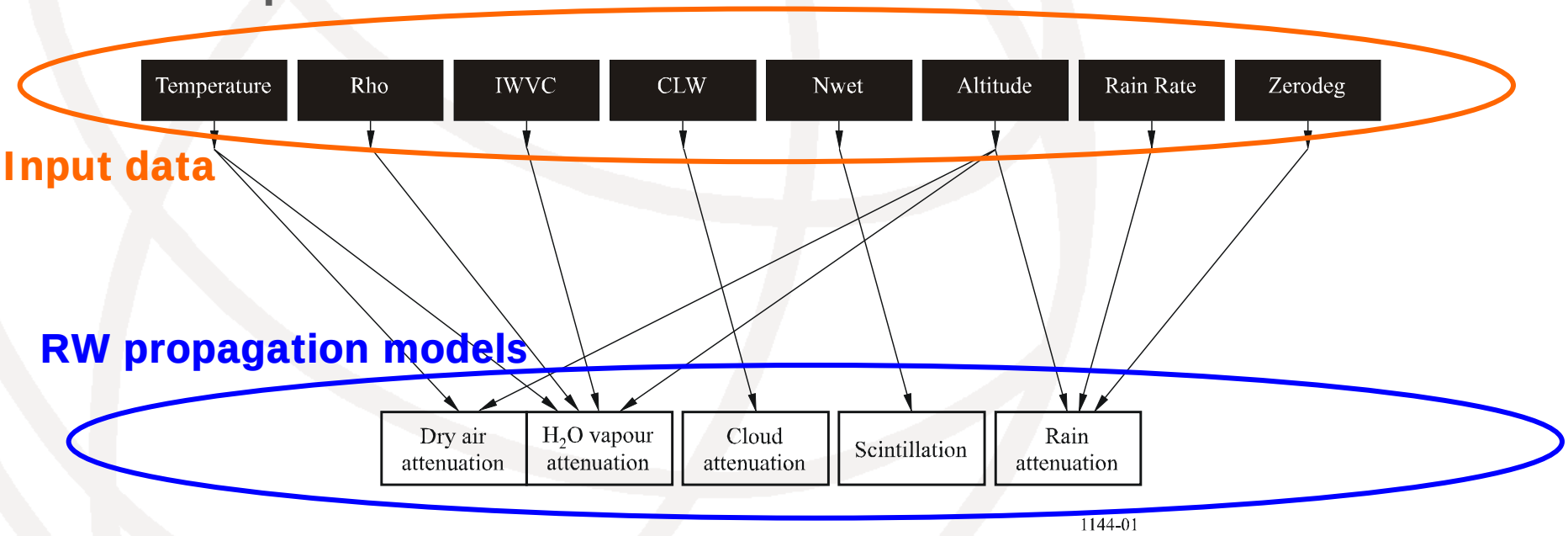
Statistics

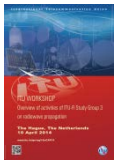


Coverage Maps

Introduction and Background

- **ITU-R P Recommendations**
- **Option between:**
  - **User provided data**
  - **global maps/standard parameters**
- **Some recs. require the use of other recs. (nested recs.)**
  Example: ITU-R P. 618

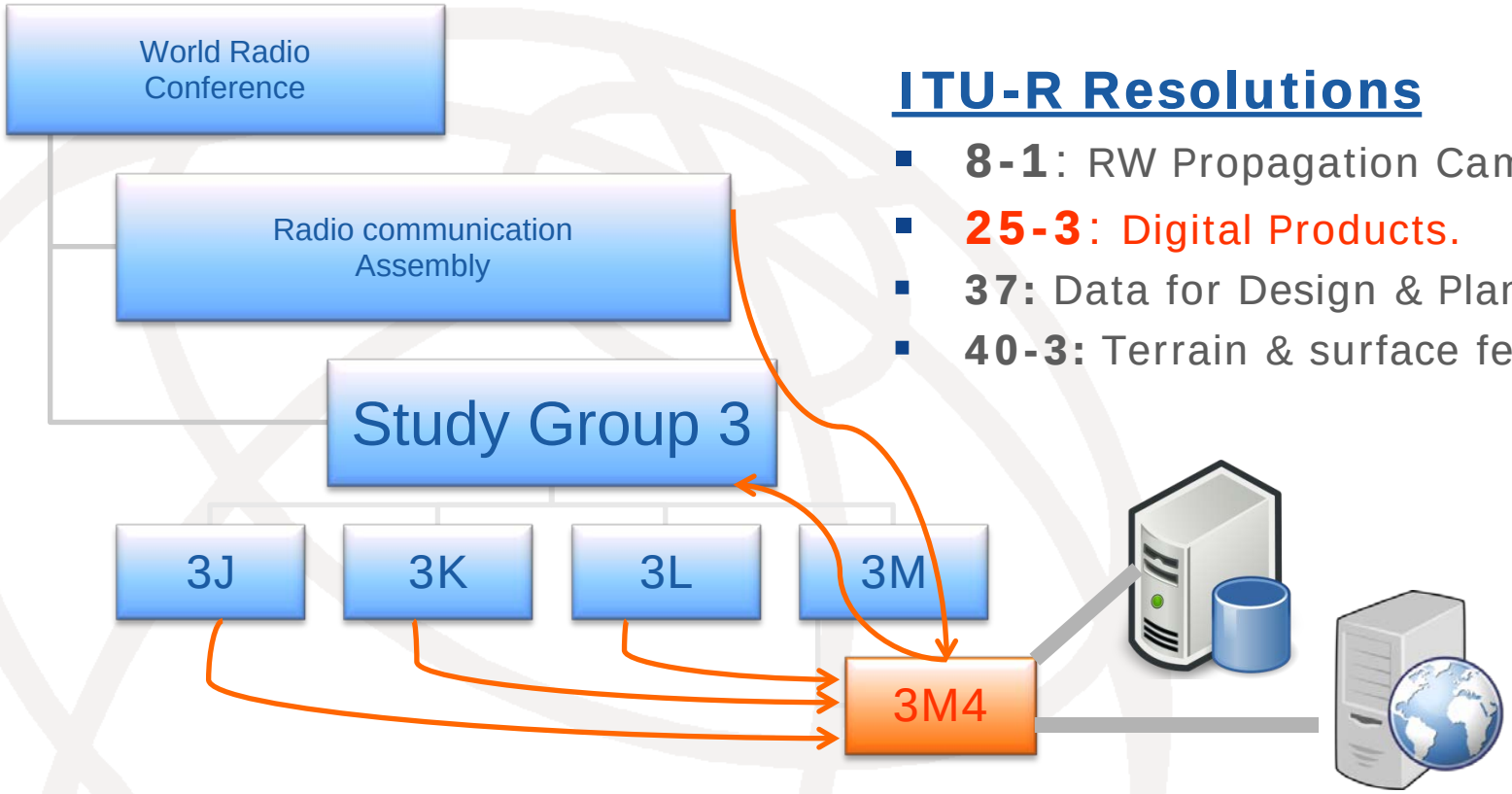




Introduction and Background

- RW Propagation Models :
  - Input parameters:
    - Tables
    - Digital Maps
    - Site specific data (e.g. raingauge VS rain maps)
  - Provided as:
    - Text in Annex (a kind of cooking recipe)
    - SW Code (Source AND/OR Executable)
  - Needs experimental data for:
    - Verification of accuracy of current models
    - SG3 Decision for adoption of a new model

Terms of Reference/ Work Method

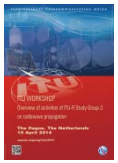


ITU-R Resolutions

- **8-1**: RW Propagation Campaigns
- **25-3**: Digital Products.
- **37:** Data for Design & Planning
- **40-3:** Terrain & surface features

ITU-R P Recommendations and SG3 docs

- **P 311:** Acquisition, presentation and analysis of data in studies of tropospheric propagation
- Format of Tables for experimental data submission
- 3M Fascicles (background and reference information on P-311)

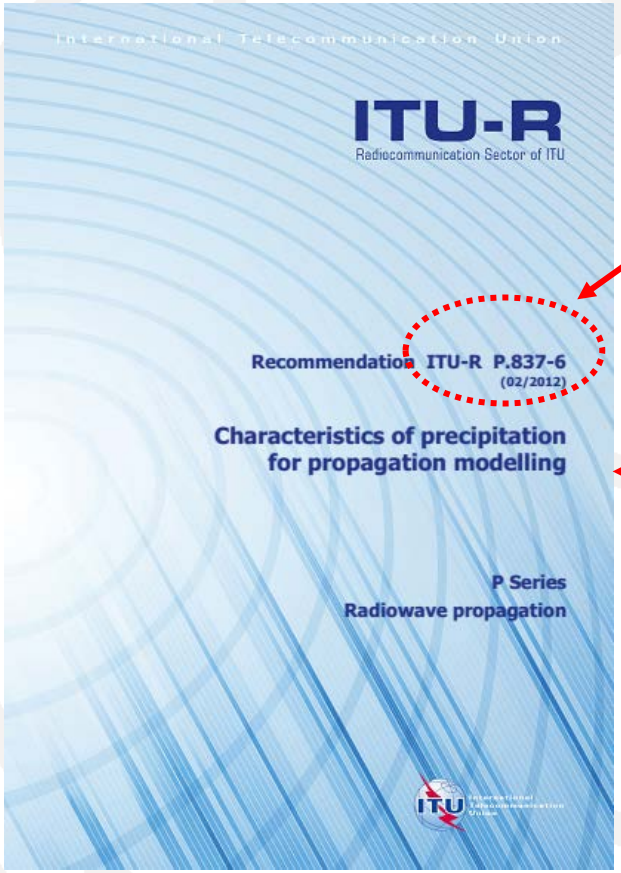


Terms of Reference/ Work Method

- Digital Products needed for Models
  - Computer Programs
  - Digital Maps
  - Reference Numerical Parameters
  - Measurement Databanks
- Digital products and P-Recs
  - Integral part = required to apply the recommendation
  - Supplemental = SW implementing the procedure in an Annex

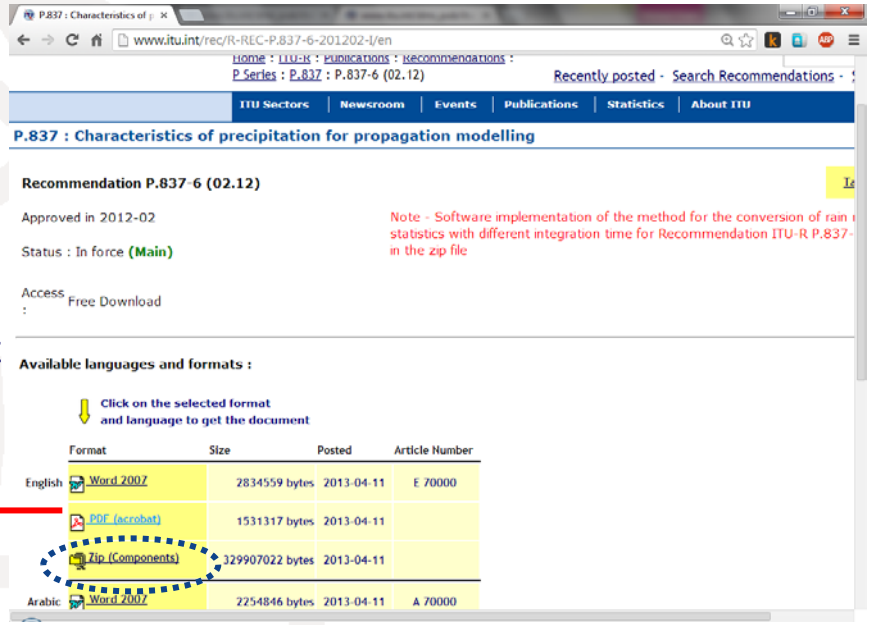
Terms of Reference/ Work Method

SW Integral part of a Recommendation



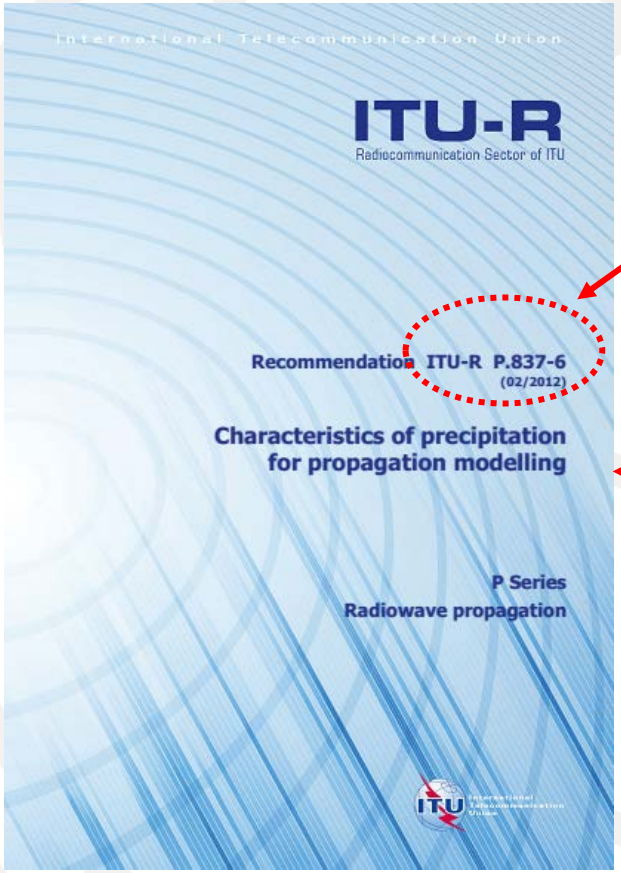
P NNN-V
(mm/yyyy)
V = vers. #
mm = month
yyyy = year

USE always last version

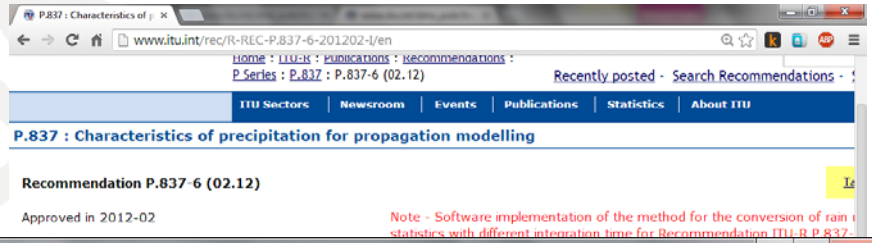


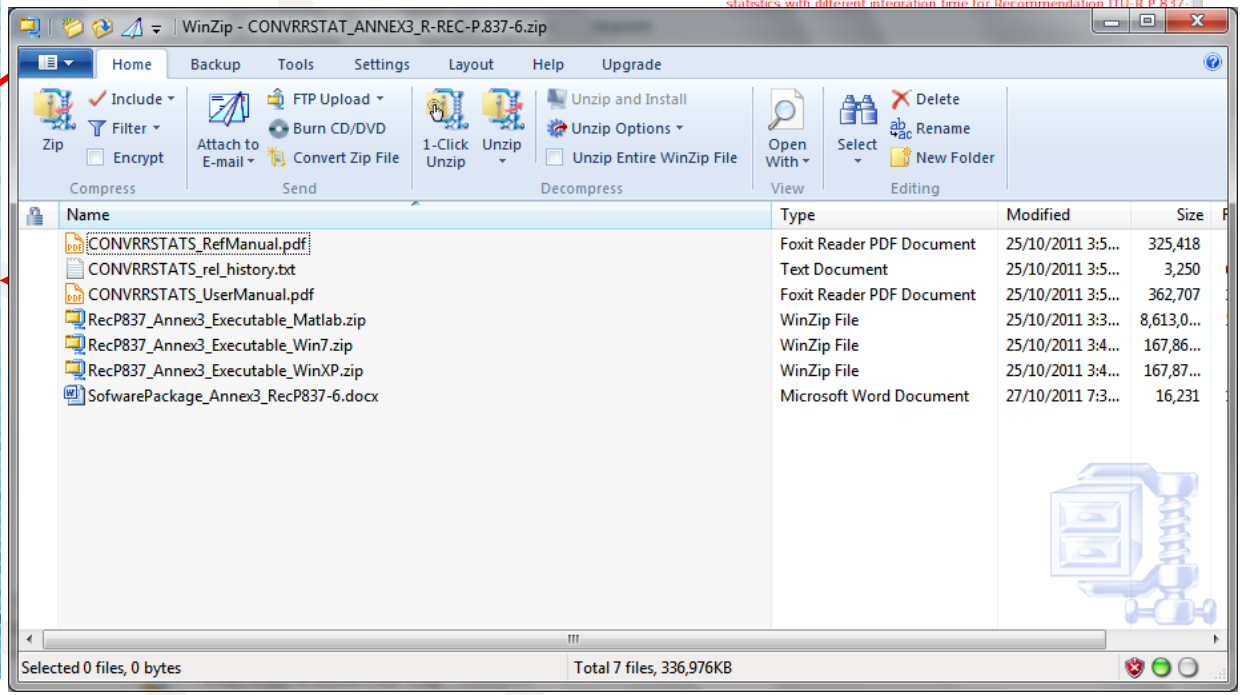
Terms of Reference/ Work Method

SW Integral part of a Recommendation



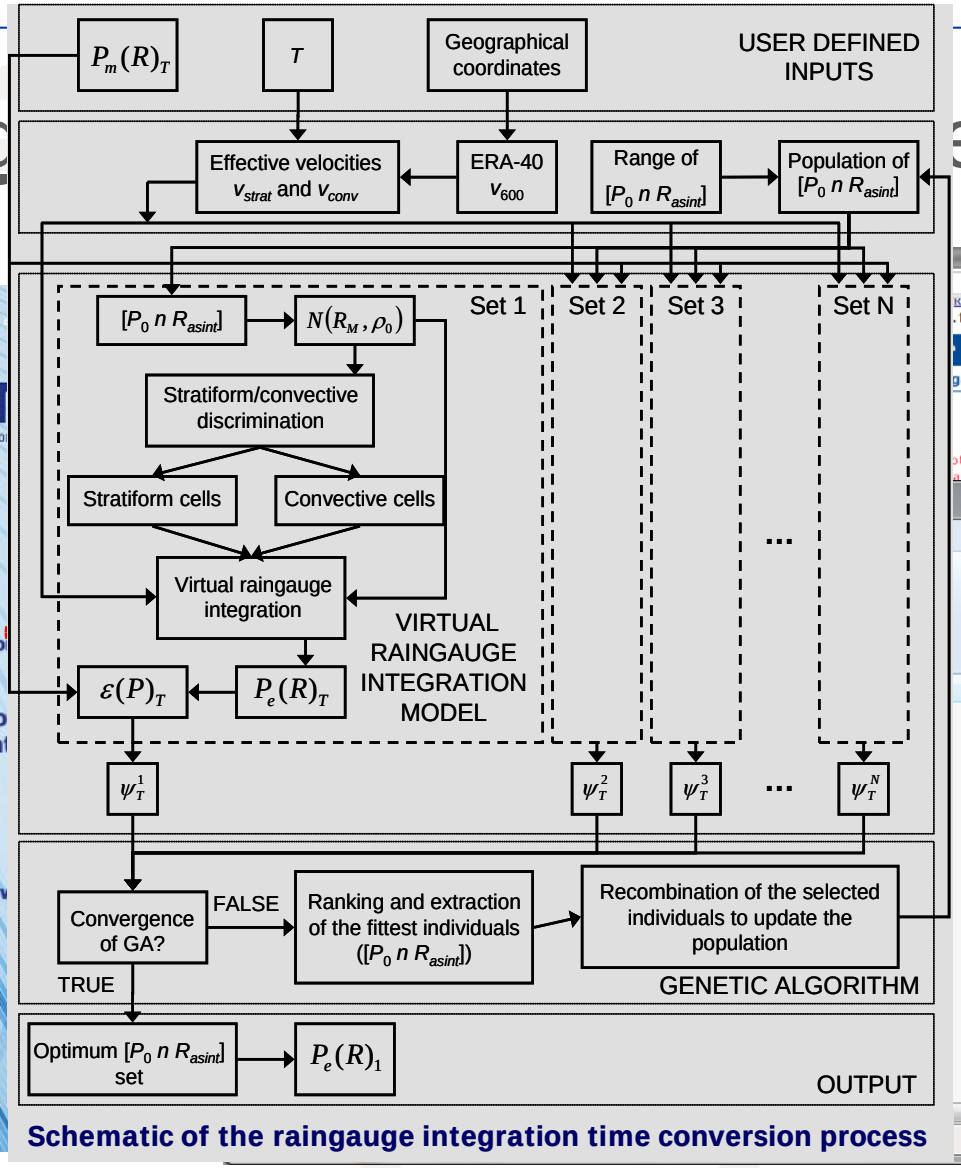
P NNN-V
(mm/yyyy)
V = vers. #
mm = month



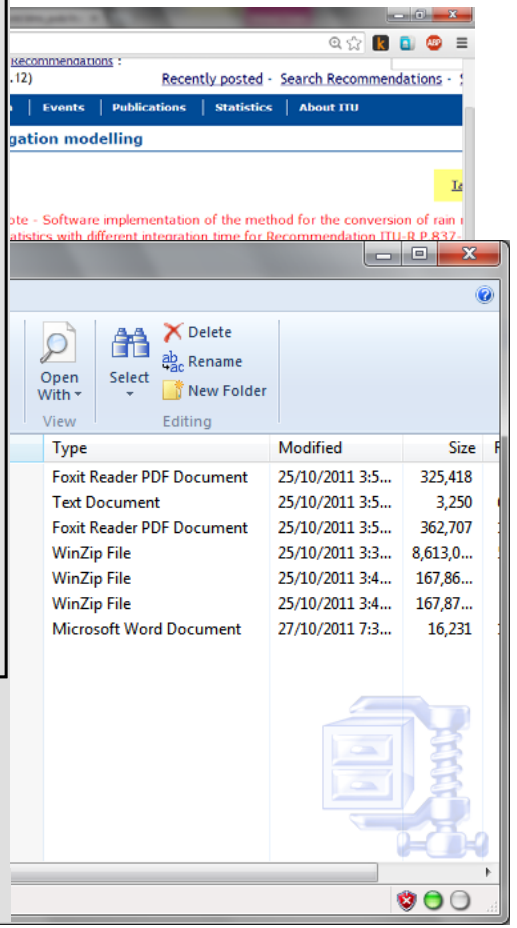


Terms of Reference/ Work Method

SW Intec ... endation

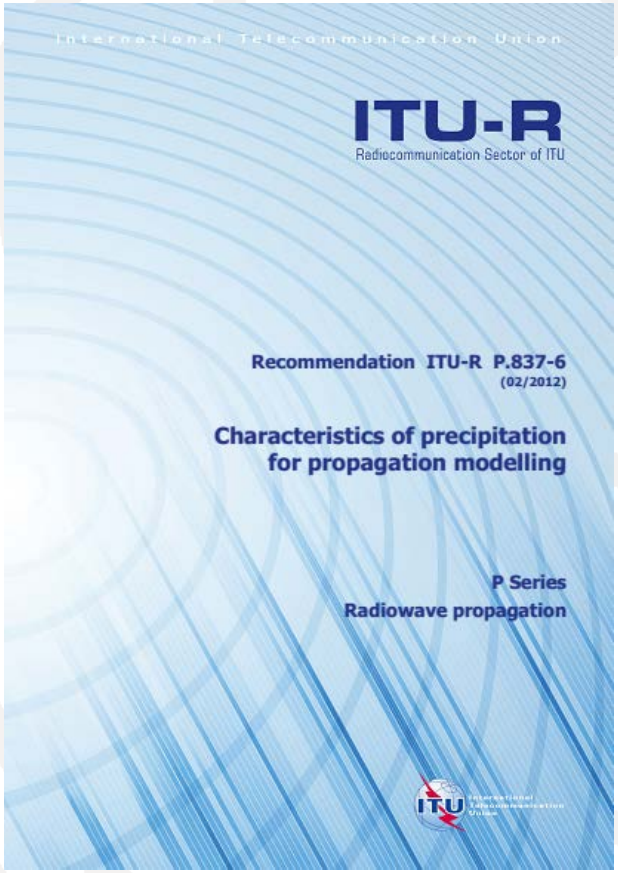


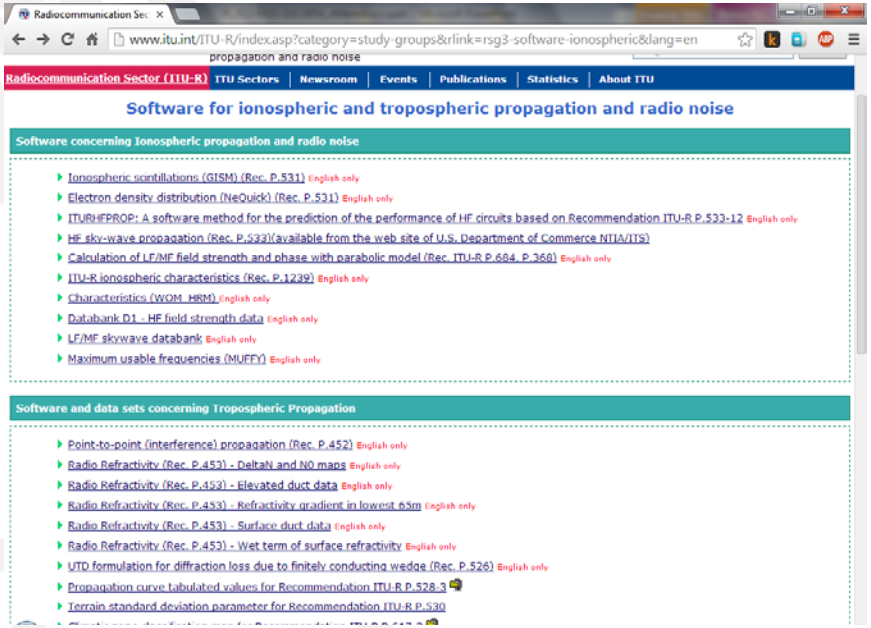
Schematic of the raingauge integration time conversion process



Terms of Reference/ Work Method

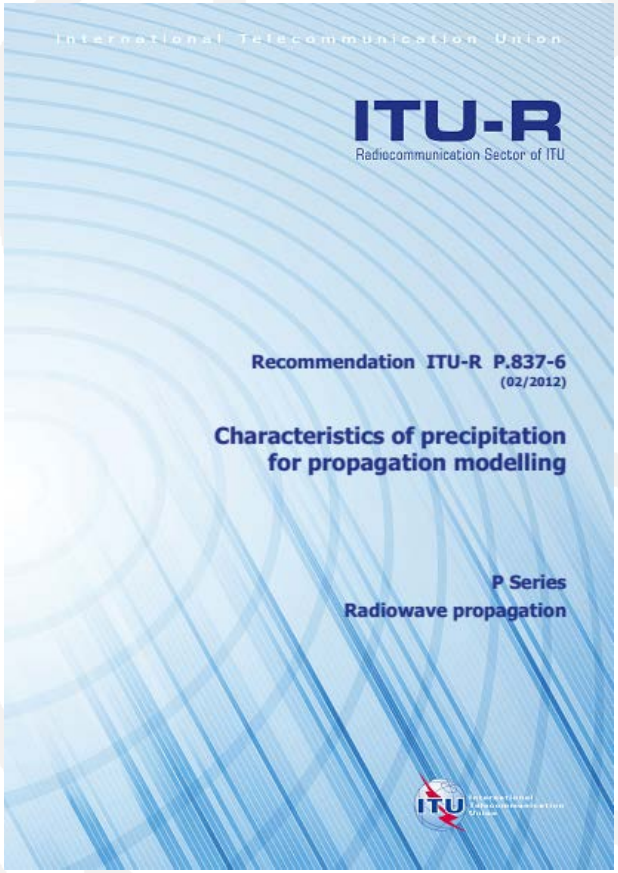
Digital Product supplemental to a Recommendation

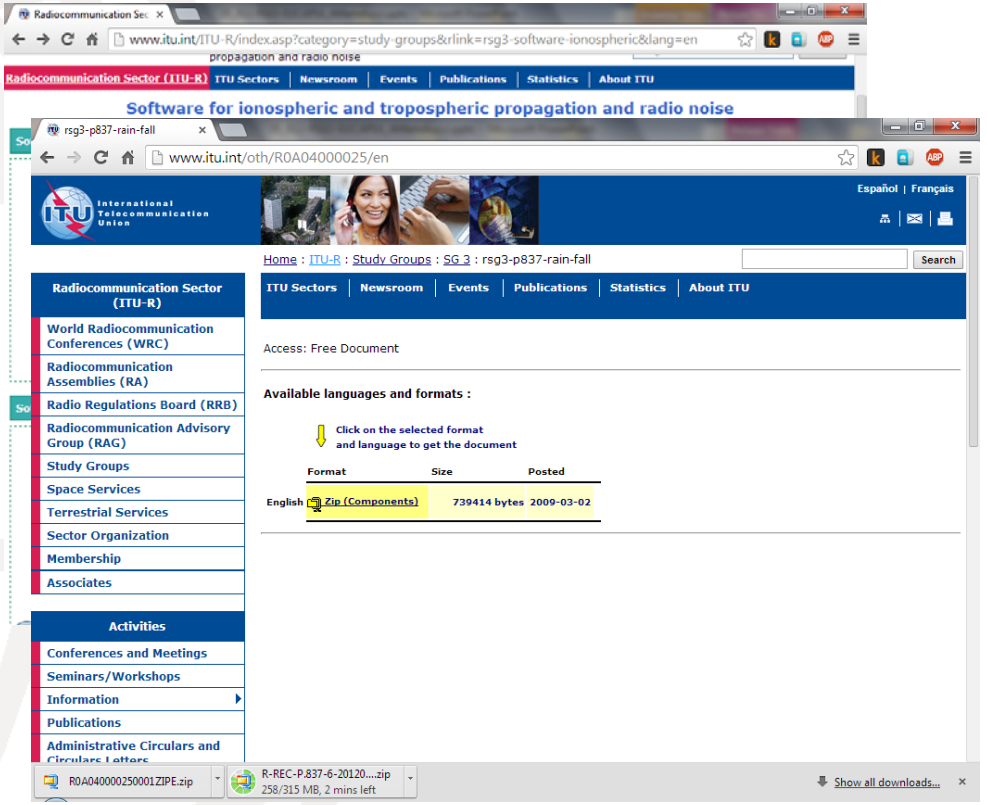




Terms of Reference/ Work Method

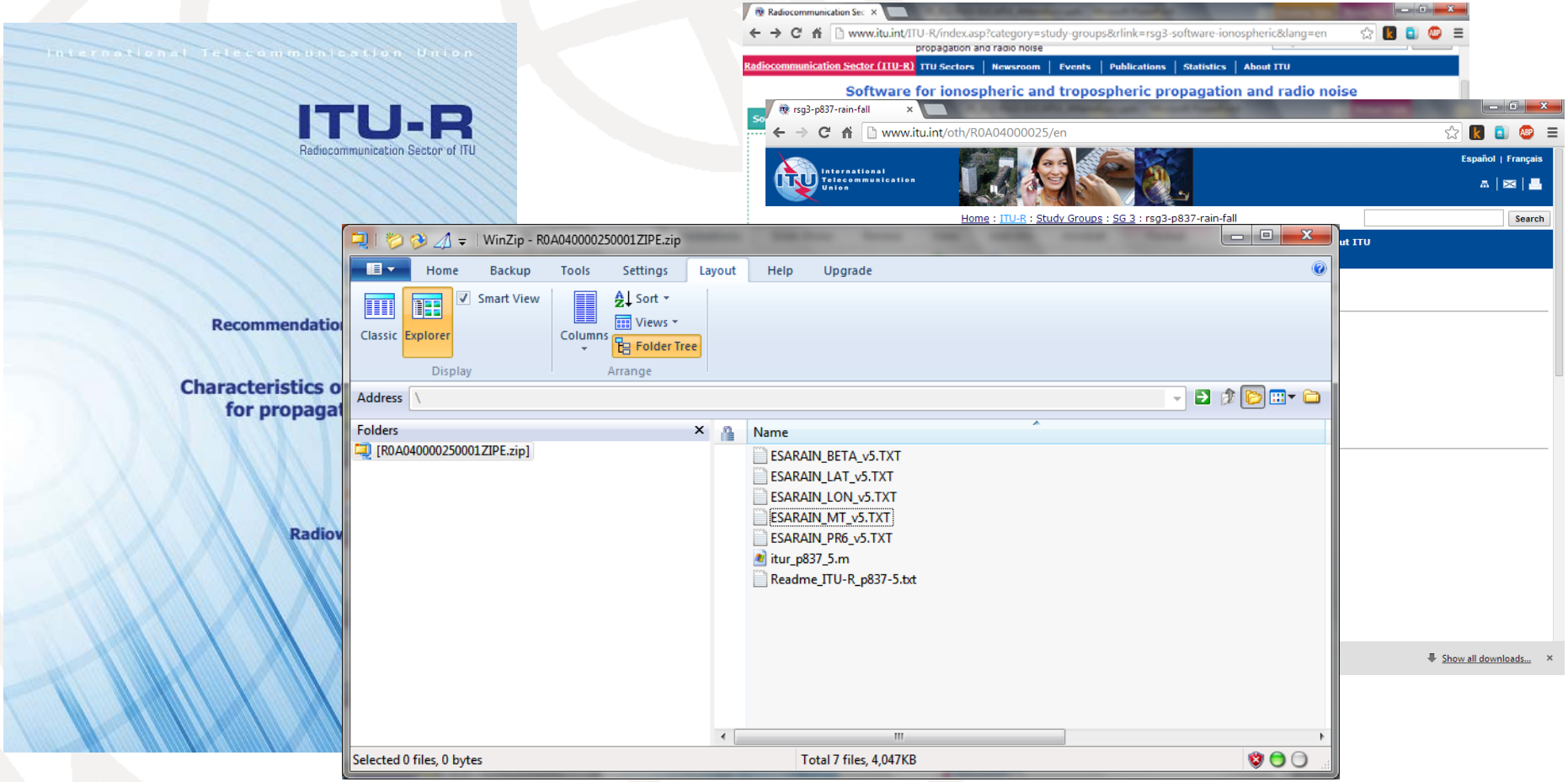
Digital Product supplemental to a Recommendation





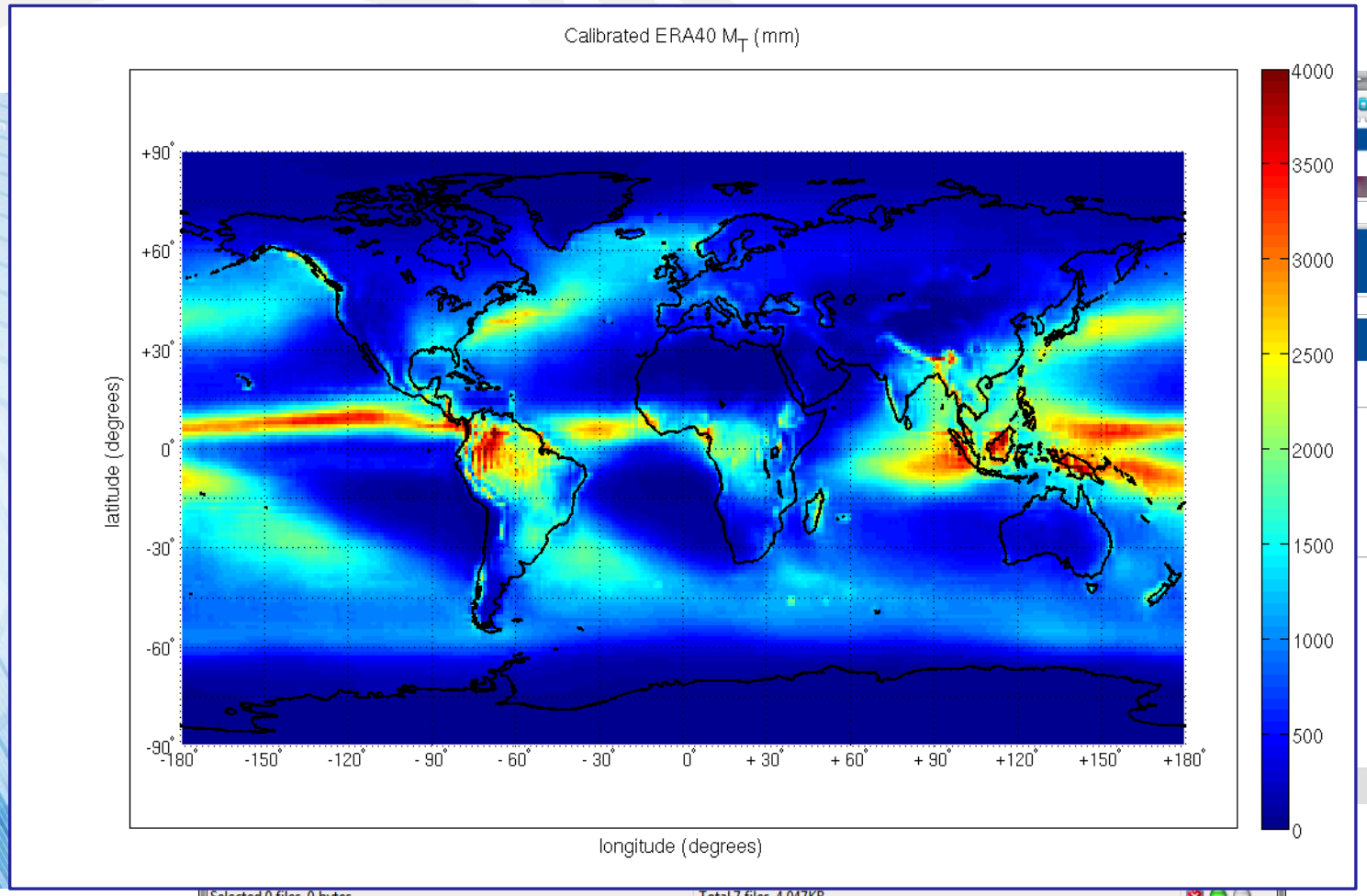
Terms of Reference/ Work Method

Digital Product supplemental to a Recommendation



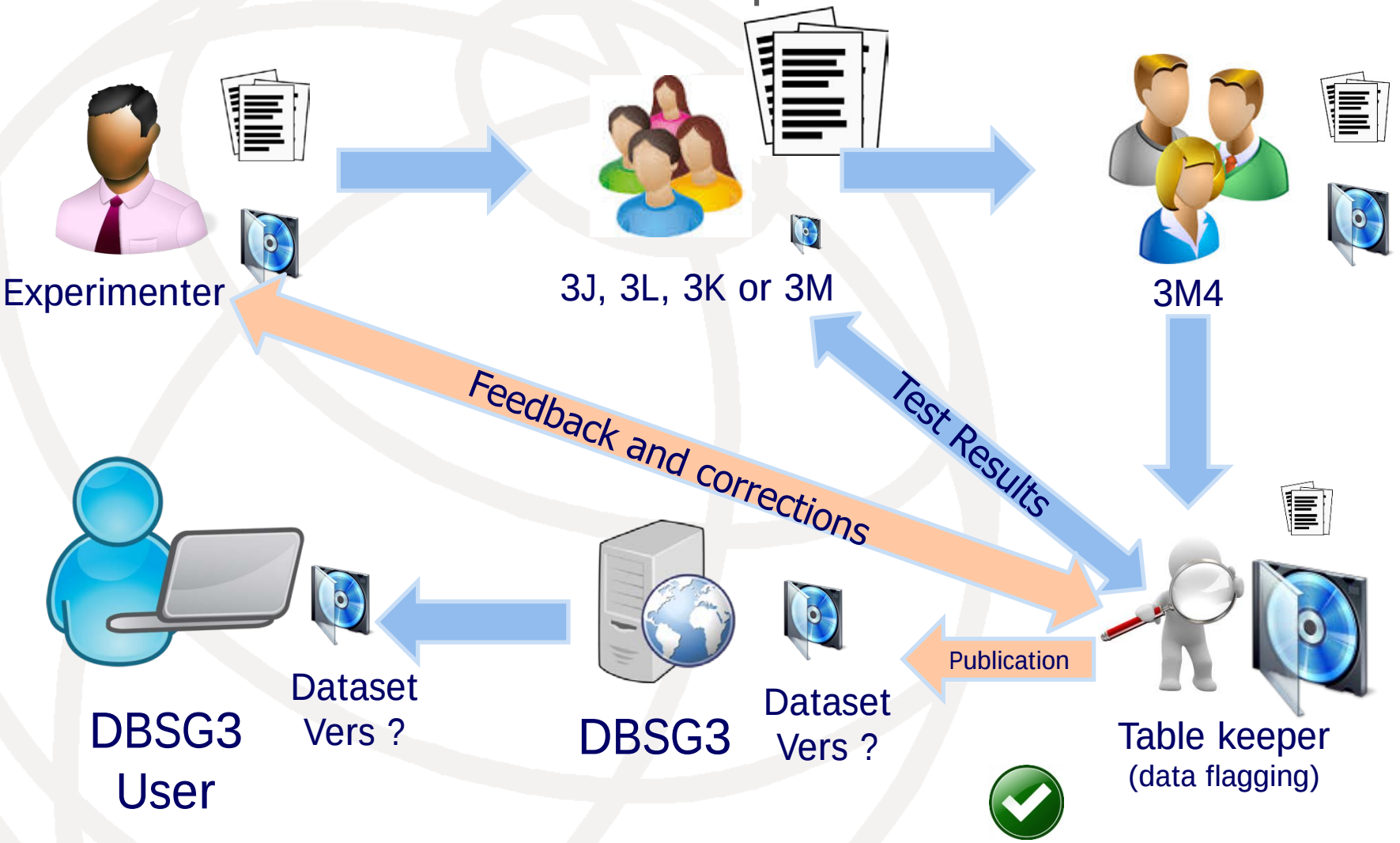
Terms of Reference/ Work Method

Digital Product supplemental to a Recommendation



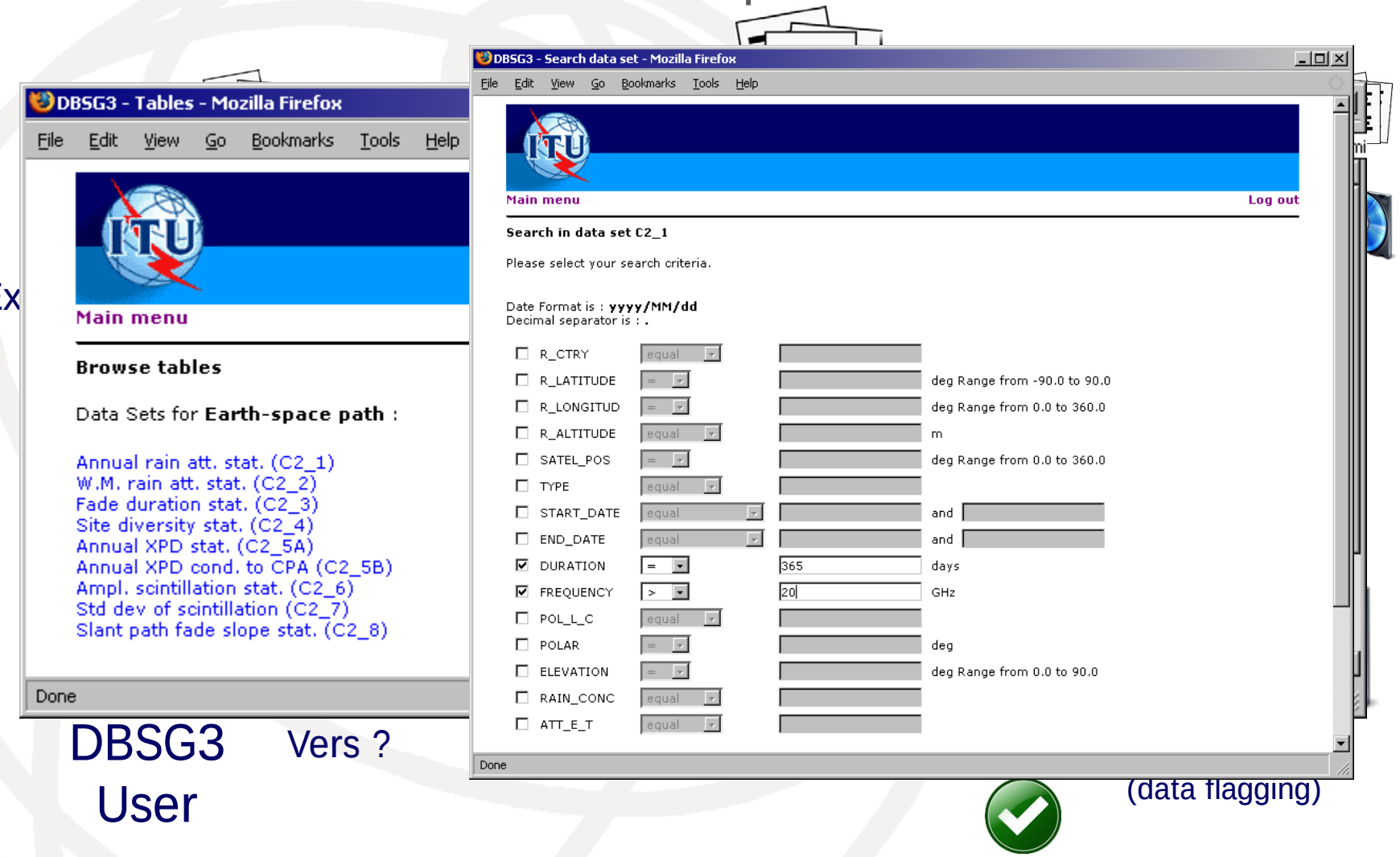
Terms of Reference/ Work Method

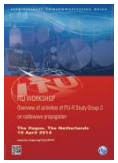
Review and distribution of experimental data



Terms of Reference/ Work Method

Review and distribution of experimental data





Experimental Data

SG3 Classification of experimental Tables

Part I: Terrestrial line-of-sight path data

Part II: Earth-space path data

Part III: Terr. trans-horizon path & rain scatter data

Part IV: Radiometeorological data

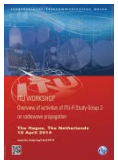
Part V: Terrestrial land mobile data

Part VI: Terrestrial point-to-area data

Part VII: Data for mobile-satellite services

Part VIII: Vegetation and building data

Part IX: Noise



Experimental Data

Part IV: Radiometeorological data

Table IV-1: Statistics of rain intensity

Table IV-2: Rain integration time conversion factor

Table IV-3: Annual statistics of sky noise temperature

Table IV-4: Statistics of mean surface refractivity

Table IV-5: Statistics of rain event duration

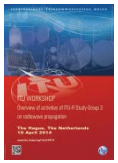
Table IV-6: Statistics of evaporation ducts

Table IV-7: Statistics of cloud cover

Table IV-8: Spatial statistics dependence of rain intensity

Table IV-9: Total columnar water vapour content

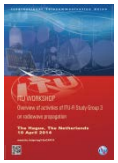
Table IV-10: Total columnar cloud liquid water content



Experimental Data

Part II: Earth-space path data

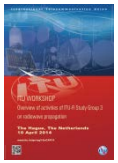
Table II-1: Slant path annual rain atten. and rain rate statist.
Table II-2: Slant path worst-month rain attenuation statistics
Table II-3: Slant path fade duration statistics
Table II-4: Slant path site diversity statistics
Table II-5a: Slant path annual XPD statistics
Table II-5b: Slant path annual XPD statistics conditioned to CPA
Table II-6: Slant path statistics of amplitude scintillations
Table II-7: Slant path standard deviations of scintillations
Table II-8: Slant path fade slope statistics
Table II-9: Slant path time diversity statistics
Table II-10: Slant path instantaneous frequency scaling statistics



Experimental Data

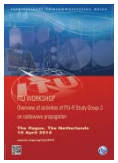
- Earth-space path (Table C2)

Table	Statistics	Total number of statistics	Number of statistics inserted since 2008
2-1	Slant path annual rain attenuation and rain rate statistics	612	16
2-2	Slant path worst month rain attenuation and rain rate statistics	77	6
2-3	Slant path fade duration statistics	86	17
2-4	Slant path site diversity statistics	59	0
2-5a	Slant path annual XPD statistics	41	0
2-5b	Slant path annual XPD statistics conditioned to CPA	43	0
2-6	Slant path statistics of amplitude scintillations	36	0
2-7	Slant path standard deviations of scintillations	52	0
2-8	Slant path fade slope statistics	0	0
2-9	Slant path time diversity statistics	0	0
2-10	Slant Path instantaneous frequency scaling statistics	0	0



Experimental Data

- Slant path annual rain attenuation and rain rate statistics (Table 2-1): Table Keeper Carlo Riva, Politecnico di Milano, Italy
  - 612 statistics, Single year or multiple years
  - Attenuation and rain rate exceeded for probability from 0.001 % to 50 % (20 points, 4 per decade: e.g. 1, 2, 3 and 5)
  - Beacon, Satellite link derived or radiometric derived attenuation
  - Latitude range: from 37.9 deg. S to 67.5 deg. N (60 statistics between +/-25 deg)
  - Observation periods in the interval 1968-2012
  - Frequency: 4-49.5 GHz (313 above 17 GHz)
  - Elevation angle: 3.3 - 90 deg
  - Statistics flagged and selected for testing by visual inspection :
    - 174 (excess/rain attenuation)
    - 97 (total attenuation)



Experimental Data

- **Slant path annual rain attenuation and rain rate statistics (Table 2-1) Testing procedure:**
  - Test variable as from of ITU-R Rec. P.311
  - Error calculated for each experiment and each probability in the validity range of the distribution (see flags)
  - Average, std and rms error for each probabilities averaged over all the selected experiments and weighted with their duration
  - Average, std and rms averaged over the probability range of interest and over all the experiments
  - Selection of the best model according to the rms (and the average) errors
- Test with input measured rain rate distributions or rain maps (ITU-R Rec. P.837)
- Test for excess and total attenuation
- Test in different probability/frequency/elevation/latitude ranges

Experimental Data

- **Slant path annual rain attenuation and rain rate statistics (Table 2-1)**

Tes

AVERAGED ERRORS SUMMARY

Method	AVERAGED ERRORS SUMMARY			WEIGHT
	MEAN	RMS	STD.DEV.	YEARS
ASSISEI	-9.7	33.2	31.8	63.1
BRAZIL	-13.3	31.8	28.9	76.1
BRYANT	-5.1	28.6	28.1	75.9
CRANETC	-1.3	40.5	40.4	76.5
DAHRAIN	-10.1	28.0	26.1	79.8
EXCELL	-1.7	29.2	29.1	79.8
FLAVIN	-7.9	27.7	26.6	76.1
GARCIA	-21.8	35.9	28.5	76.1
GLOBAL	8.3	33.9	32.9	75.3
ITU-618	-9.1	31.6	30.3	79.8
JAPAN	-12.7	32.7	30.2	70.2
LEIWA-S	-22.1	34.5	26.5	48.9
MATRICC	3.5	32.5	32.3	78.5
SAM	-9.1	35.1	33.9	76.1
SVIATOG	-21.9	41.2	34.9	76.1

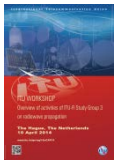
all

erest

ge)

Rec.

Historical Example: from COST 255 FR



Conclusions/ The way ahead

- **Method of work**
  - Demanding but consolidated for measurements
  - New role for SW, but method ?
- Need for new propagation data
  - New campaigns (climates, frequencies, systems)
  - Improvement of accuracy
  - New parameters
  - New/reviewed test variables
  - Data flagging and Test procedures