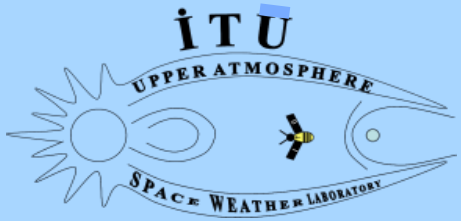


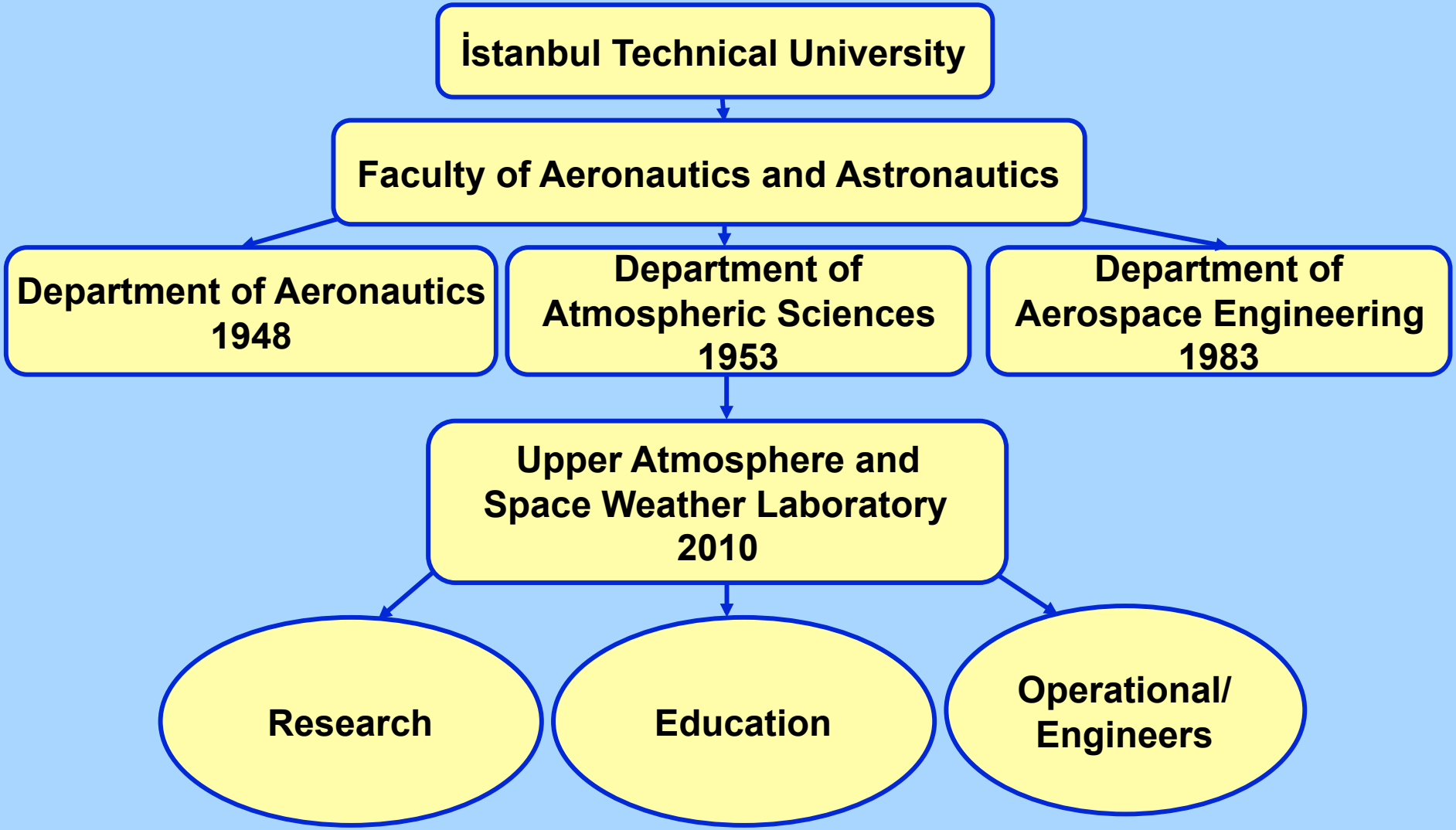
İTU Space Weather Lab and CCMC Possible Collaborative Works

Zerefşan Kaymaz

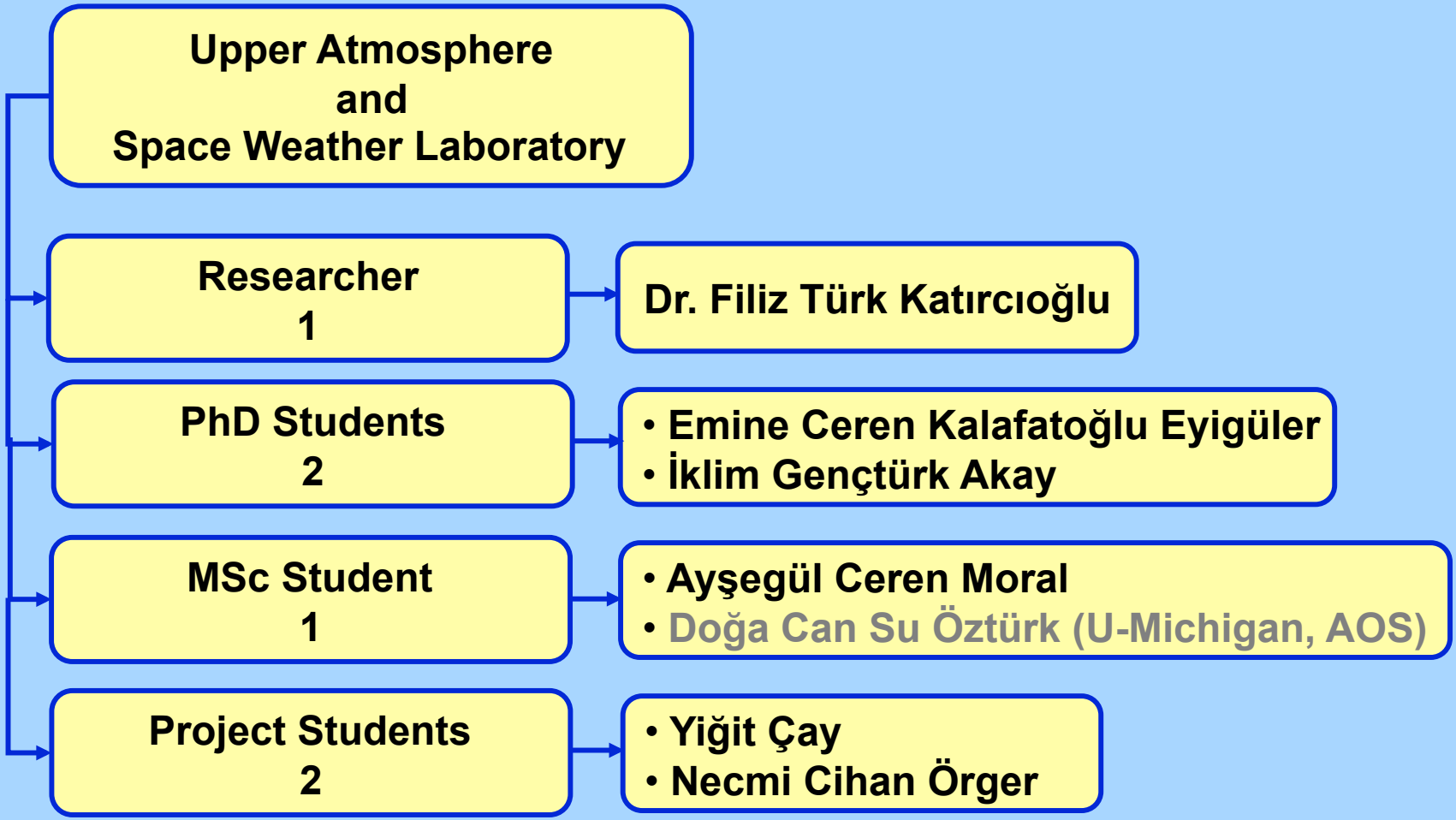
Emine Ceren Kalafatoğlu Eyigüler

İstanbul Technical University

İTU Space Weather Laboratory



Research Group



Laboratory Infrastructure

- **Ionosonde measurements**
  - since Oct 2012
  - 79 ionospheric parameters
  - Ionograms (4 min, shorter possible)
- **Magnetotelluric measurements for GIC studies**
  - Since Sept. 2013
  - Electric field data
  - Magnetic field data
- **SID VLF Data**
  - VLF data from 6 stations
  - Since June 2010

- **3 workstations**
- **IDL (network for 10)**
- **Data storage system for 3 years of ionosonde data**
  - Not restricted to ionosonde
  - Expansion subjected to funding
- **Large TV monitors for visualization of model results**
- **www.spaceweatherlab.itu.edu.tr**

- **Instrumentation Lab (in progress)**
  - Plasmameter for cubesat
  - X-Ray spectrometer
  - Testing

- **<u>Faculty infrastructure</u>**
  - Clean room
  - Tests in Vacuum Conditions
- **Experience in Cubesat**
  - First Cubesat (LEO, Sep. 2011)
  - Cubesat sail (in progress)

User end of CCMC models

- Research
  - Request Runs
  - Metrics and Validation
- Education
  - ISWA
  - CCMC Competition
- Operational
  - R2O

Research Projects-I

- **Projects funded by TUBITAK and ITU**
- **Thesis Students**
  - **A Comprehensive Study of Stormtime Joule Heating Using Combined Observations and Coupled Space Weather Models**
  - **Magnetotail Shape, Flow And Magnetic Fıeld Structure at Lunar Distances: Artemis Observations and Model Comparisons**
  - **Ionospheric Variability over Istanbul Usıng SID-VLF and HF-Radar Observations**

  - **Plasmameter on a magnetospheric polar orbiting cubesat sail: design and testing for space weather effects**

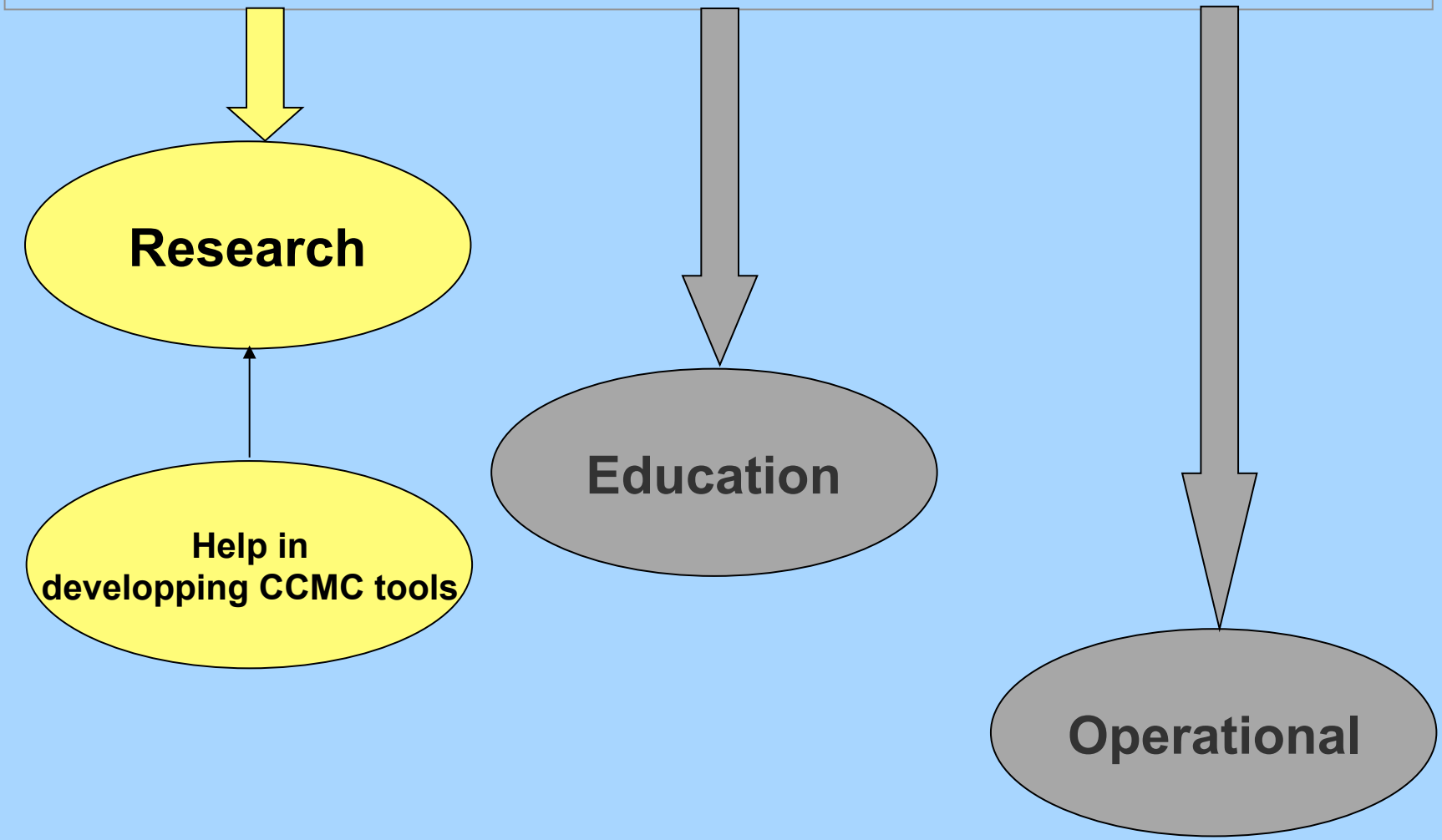
Research Projects-II

- **Space Weather from the Moon to the Ionosphere, *TÜBITAK project***
- **GIC determination using magnetotelluric methods in İstanbul, *TUJJB project***

İTU Research Program-Student Support:

- **Investigation of Upper Atmospheric Joule Heating using Magnetospheric spacecraft, Ground based Observations and Space Weather models**
- **Determination of Earth's magnetospheric environment at Lunar Distances using Artemis spacecraft**
- **Ionospheric Variability over İstanbul using SID-VLF and Ionosonde data**

Collaborations in



Research: Validating models

Possible Tasks

- Model validation
  - Testing
    - Against data
      - e.g. CHAMP/TIMED
    - Model-model
  - Evaluating through
    - Case studies
    - Statistics
- Setting up space weather metrics
  - Different metrics for different models
- Selection of Criteria/Parameter to be used for comparison

Associated Study

- Models for Comparisons with Artemis Magnetotail mappings at Lunar distances
  - SWMF BATSRUS
  - OpenGCM
  - LFM
- M-I Coupling: Joule Heating / Neutral Wind
  - SWMF BATSRUS
  - OpenGCM
  - LFM
  - TIEGCM
  - GITM
- Ionospheric Variability
  - IRI
  - TIEGCM
  - GITM
- GIC Determination
  - Ground based magnetic and electric perturbations
- Solar/Heliospheric
  - ENLIL

Help in Developing CCMC Tools-I

- Help on model coupling
  - Coupling between individually running models
- Help to improve Space Weather predictions
  - CME arrival times
  - CCMC K-index
- Help to improve Kameleon Library
  - e.g. interpolation routines
- Help on common interfaces visualization
  - Creating animations/movies

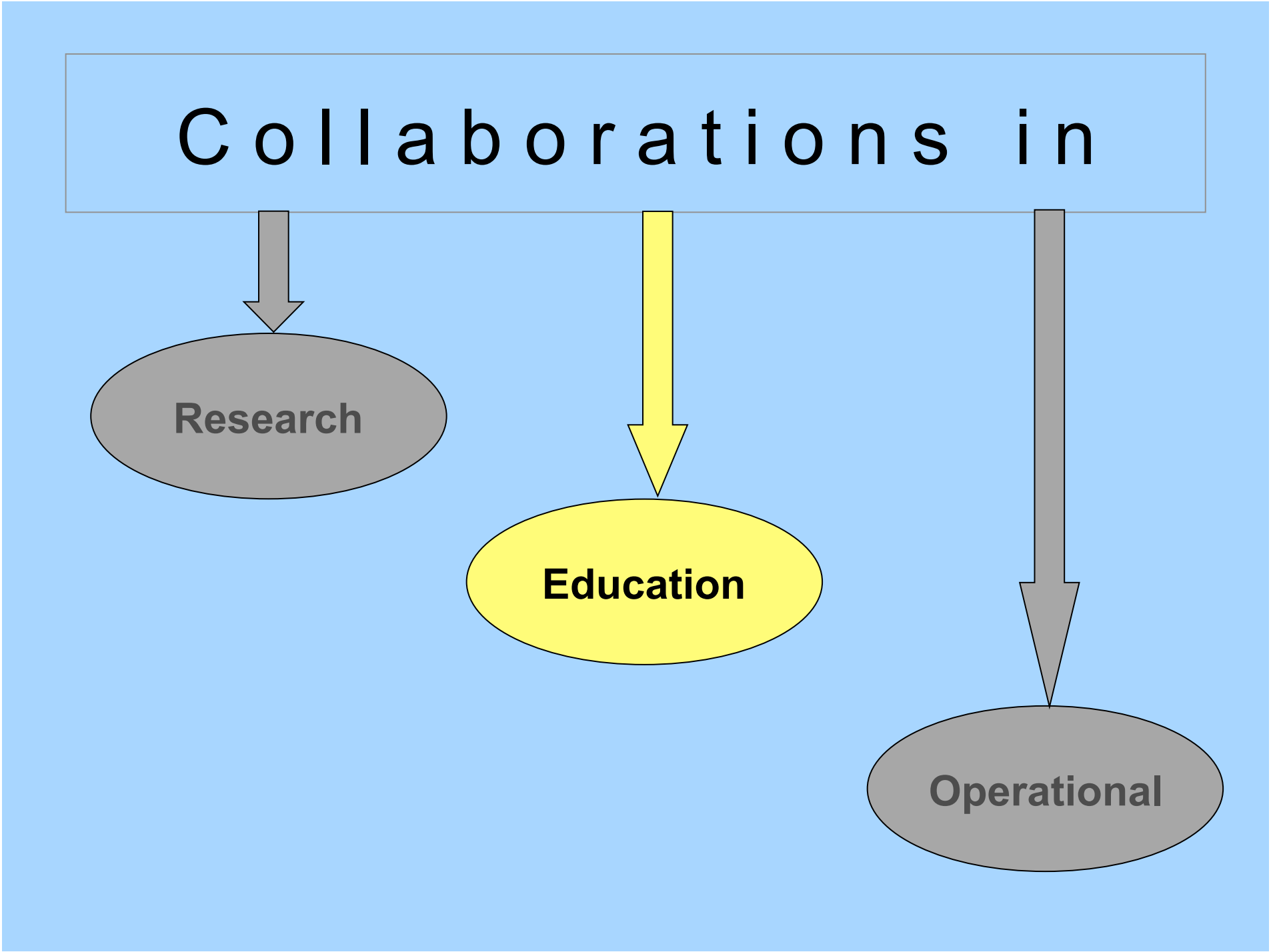
- Data assimilation
  - Neutral Upper Atmosphere
    - Integrating ground based measurements with models
      - SUPERDARN
      - TIMED
- Help to improve and expand Regional-K index and dB/dT studies to ***midlatitudes***

Help in Developping CCMC Tools-II

- Take place in International Steering Commitee
- Take place in working groups

In a broader sense:

- Help in developing ***International*** Space Weather Prediction Center
- Help in developing International Summer Schools/Workshops/Conferences
- Actively participate in CCMC workshops/conferences
- Help in developing educational programs, software, material etc.
- Help in increasing Public Awareness: Brochures, newsletters, etc.


Collaborations in
Research
Education
Operational

Education

Undergraduate Level of Courses

- **Space Environment (70-80 students)**
  - **Environment**
  - **Effects of Environment on Spacecraft and ground systems**
- **Physics of Upper Atmosphere (10-20 Students)**
  - **Magnetosphere, ionosphere, thermosphere**
- **Planetary Atmospheres (10-20 Students)**
  - **Neutral atmospheres: Lower atmosphere, Thermosphere**
  - **Magnetospheres, ionospheres**
  - **Applications for Venus, Mars, Jupiter, and Titan**
- **Operational Space Weather (New Course in prepapration)**
  - **Introduction to modeling concepts**
  - **Introoduction of available models at CCMC**
    - **Solar**
    - **Magnetospheric**
    - **Ionospheric**
    - **Thermospheric**
  - **Application of models**

Education

- Space environment
  - Homework
  - Term Projects (1-2)

- Student Background
  - Aerospace Engineering
  - Atmospheric Sciences
- Homework
  - According to the subject of the week
  - Data related, using CDAWeb base
  - Programming, Plotting, Analysing, Interpreting
- Term Projects
  - Environment related
  - Space Weather Effects

- <u>Environment related subjects</u>
  - Cme recognition
  - Shock recognition
  - Mpause recognition/calculation
  - Storm/Substorm recognition
  - Joule Heating and Auroral effects
- <u>Space Weather Effects/Operational</u>
  - Drag
    - Density Variations
    - Drag
    - Satellite life time under different solar & magnetospheric conditions
  - Spacecraft Charging
  - Radiation dose
    - Joule heating
    - Energetic particles
    - X-Ray flux
  - SPENVIS / ESA

- Physics of Upper Atmosphere
  - Homework
  - Term Project (1)

  - Term Projects
    - M-I Coupling
    - Ionospheric
    - Thermospheric

- Planetary Atmospheres
  - Homework
  - Term Project (1)

Term Projects

- Space Weather Effects on Upper Atmosphere
- Storm/Substorms
- Joule Heating and Auroral effects on Upper Atmosphere
- Models
  - NRLMISIS
  - IRI
  - TIEGCM
  - SPENVIS /ESA

- Models:
  - planetWRF model: GCM
    - for Mars, Jupiter, Titan
  - Magnetospheric models for Jovian Magnetosphere

Education

- **Operational Space Weather**
  (New Course in preparation)
  - Introduction to modeling concepts
  - Introduction of available models at CCMC
    - Solar/Heliospheric
    - Magnetospheric
    - Ionospheric
    - Thermospheric/NeutralAtm
  - Application of models

Education and ISWA

(Integrated Space Weather Analysis)

Iswa Tools

- Analyzing coronal mass ejections/active regions
  - Propagation
  - Detection
  - Analyses
  - Solar observations/images
    - Solar/Heliospheric Images
    - In-situ observations
    - Interpretations
- Monitor space weather and make predictions
  - CME arrival time:1-4 day predictions
  - Mpause/Bshock
  - IMF-Solar Plasma correlation (ACE)
  - Storm/Substorms (Kp/AE)
- Spacecraft anomaly resolution
  - Operational space weather
    - CME propagation
    - Impact
    - Fok ring current and enegetic particles
  - GICs

- All observations are easy reachable at one location
- Alternative instruments available if one is down

- Difficulty was/is: *Time!!*
  - Finding events??
  - Grading .....
- 70-80 students
- Group Assignments and Projects possible with ISWA

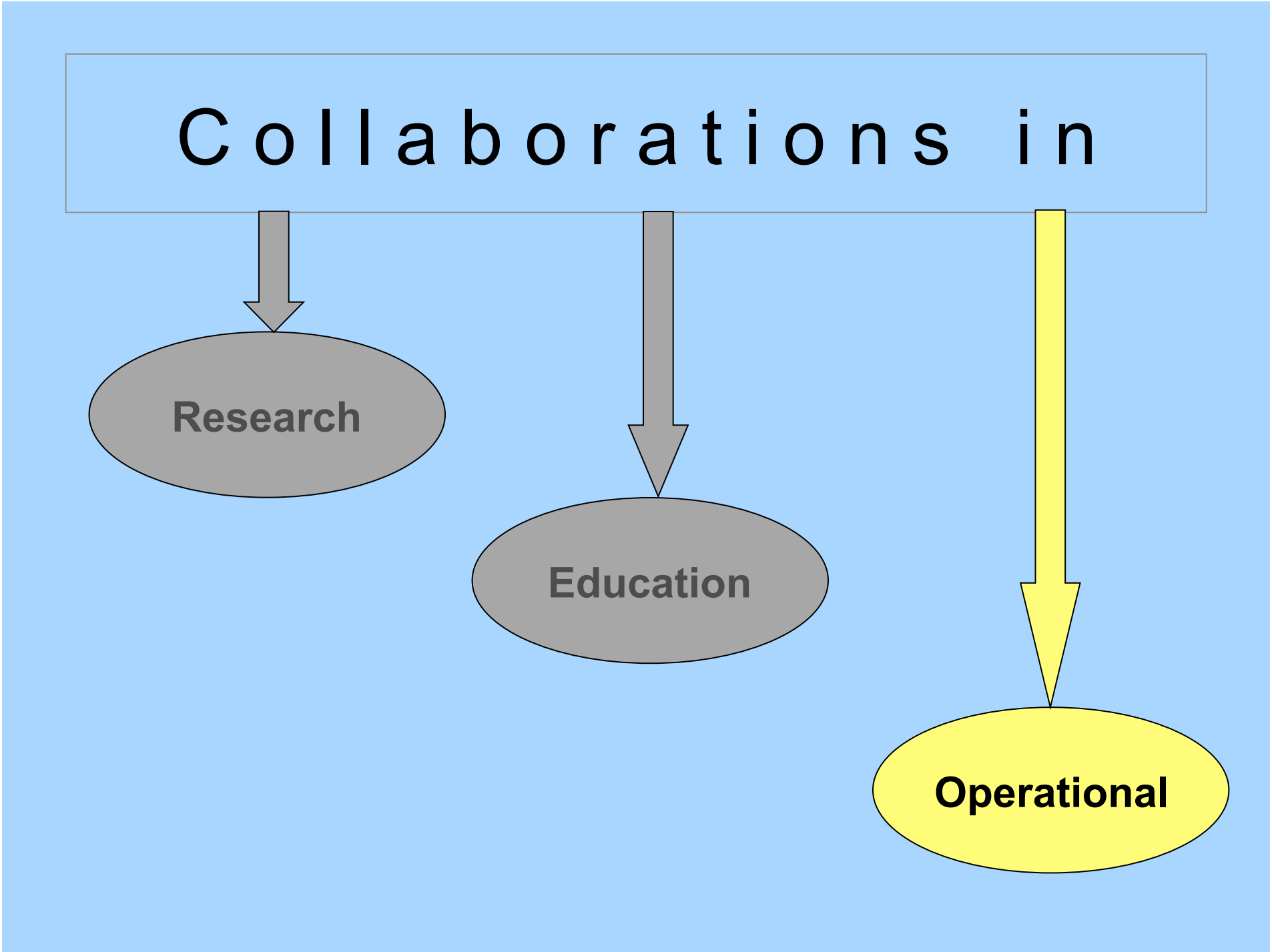
Education and ISWA

(Integrated Space Weather Analysis)

Planned activity

- **Purpose: to introduce space environment using ISWA**
  - **Hands on experience on ISWA**
- **Local Organizer: Space Weather Lab.**
- **Who:**
  - **Students who took the course on Space Environment**
  - **Students in Space Science and Engineering**
  - **Students in Atmospheric Sciences**
- **When: Winter/Feb or Summer/May School every year**
- **How long: One Week on a selective topic**
- **Participants: Invite scientist to teach (??)**
- **Expand to international students in the future (??)**
  - **Istanbul: easy reachable location**
  - **Cheaper when compare with many other locations**

- **One Missing Part is the "INSTRUMENTATION"**
- **Basic instrumentation should be introduced to users/students**


Collaborations in
Research
Education
Operational

Operational and ISWA

- **Iswa Tools can be used to determine the space weather conditions associated with a spacecraft anomaly**
- **However, it does not have a utility to address on**
  - **Spacecraft charging**
  - **Radiation Dose Analysis**
  - **Drag Analysis**
- **Which are required/demanded by many of spacecraft associated agencies/companies here including; Customers**
  - **TAI : Turkish Aerospace Industries Inc.**
  - **ASELSAN: Turkish Defense and Aerospace Industries Inc.**
  - **HAVELSAN: Turkish Aerospace Software and Systems Inc.**
  - **TÜBİTAK SAGE: TÜBITAK Defense Research Developing Institute**

Summary

- Determine priority activities
  - Research
  - Education
    - Students
    - Public awareness
  - Operational
    - Air Force Academy
    - Defense Institutions
    - Satellite agencies (Universities/Research Agencies/Companies)
    - Interdisciplinary Sciences such as Material Sciences/Companies and related
- Some already are ongoing
  - Basic Research
- Some need to be practised
  - 70-80 students (??)
    - Measuring Success
      - Group activities
      - Individual Success
    - Work Load ??!!
      - Students 15 hr/week
      - Evaluators

?Eurasia end of CCMC

- **Thank you for your attention...**
- **Questions, Suggestions...**