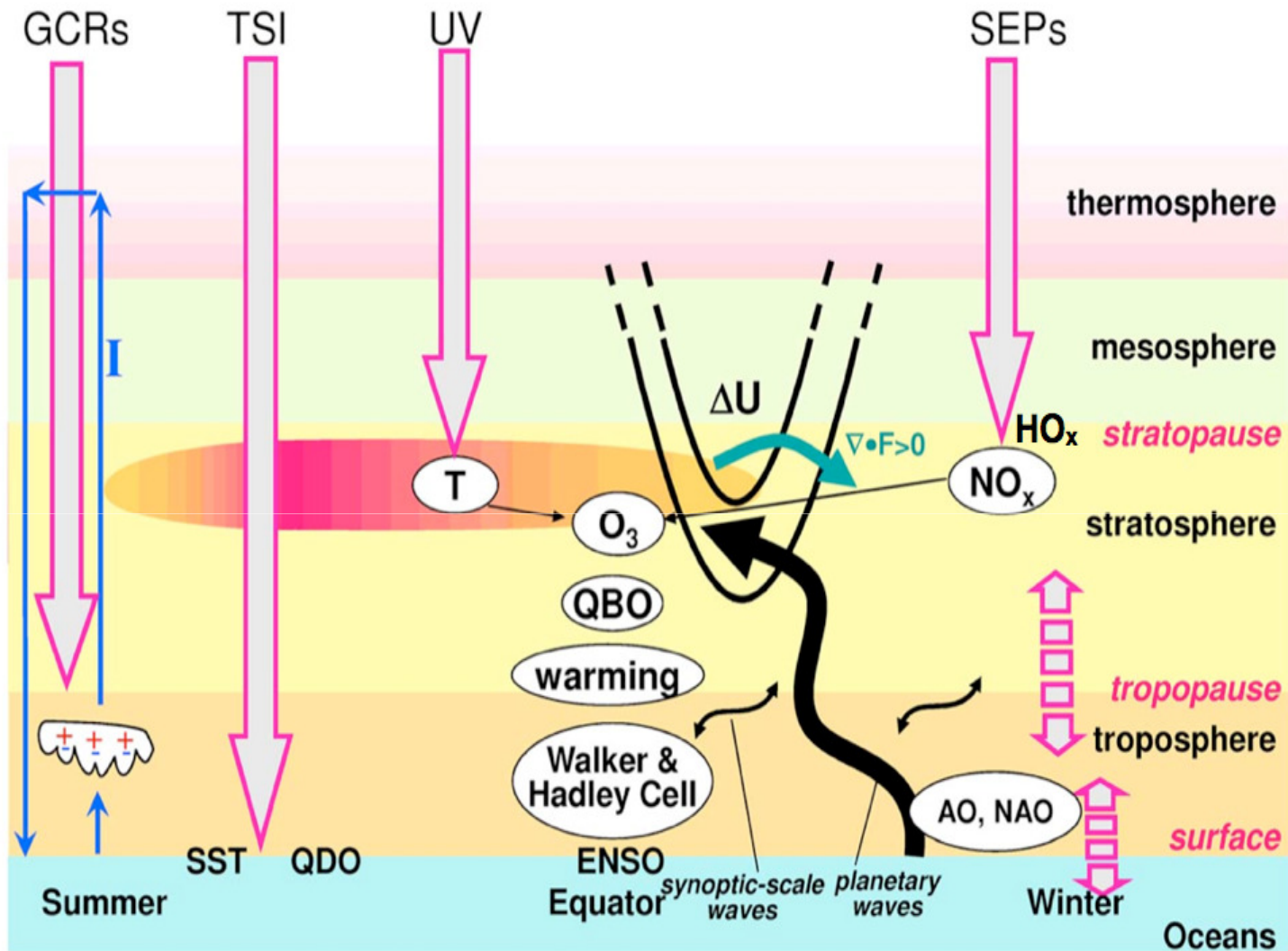


**ROSMIC is organized into four working groups to address these questions. These groups and their leaders are:**

- **Solar Influence on Climate:** Bernd Funke (Instituto de Astrofísica de Andalucía, Spain), Alexei Krivolutsky (Central Aero-logical Observatory, Russia), Tom Woods (LASP, USA).
- **Coupling by Dynamics:** Takuji Nakamura (National Institute of Polar Research, Japan), Claudia Stolle (GFZ German Research Centre for Geosciences, Germany), Erdal Yigit (George Mason University, USA).
- **Trends in the MLT:** Jan Lastovicka ( Institute of Atmospheric Physics, AS CR, Czech Republic), Dan Marsh (NCAR, USA)
- **Trends and Solar Influence in the Thermosphere:** Duggirala Pallamraju (Physical Research Laboratory, India), Stan Solomon (NCAR, USA)



Mechanisms of Solar Influence (after Gray et al, 2010)

# Working Group 1

- **Drivers of solar forcing: How well do we know their magnitude and variability?**
  - What is the accuracy for the SSI observations and models and how can it be improved?
  - How much does the TSI background vary on longer (secular) timescales?
  - How is atmospheric ionization by energetic particles distributed in the atmosphere?
  - How will the solar irradiance, precipitating particle, and cosmic ray inputs evolve during solar cycle 24 and beyond?



# Working Group 1

- **Current activities:**
  - Links to other VarSITI projects (e.g. SPECIMEN)
  - EU SOLID project
  - NASA SORCE mission at LASP
  - TOSCA cost action
  - ISSI project ““Specification of Ionization Sources Affecting Atmospheric Processes” (I. Miranova)

# Working Group 1

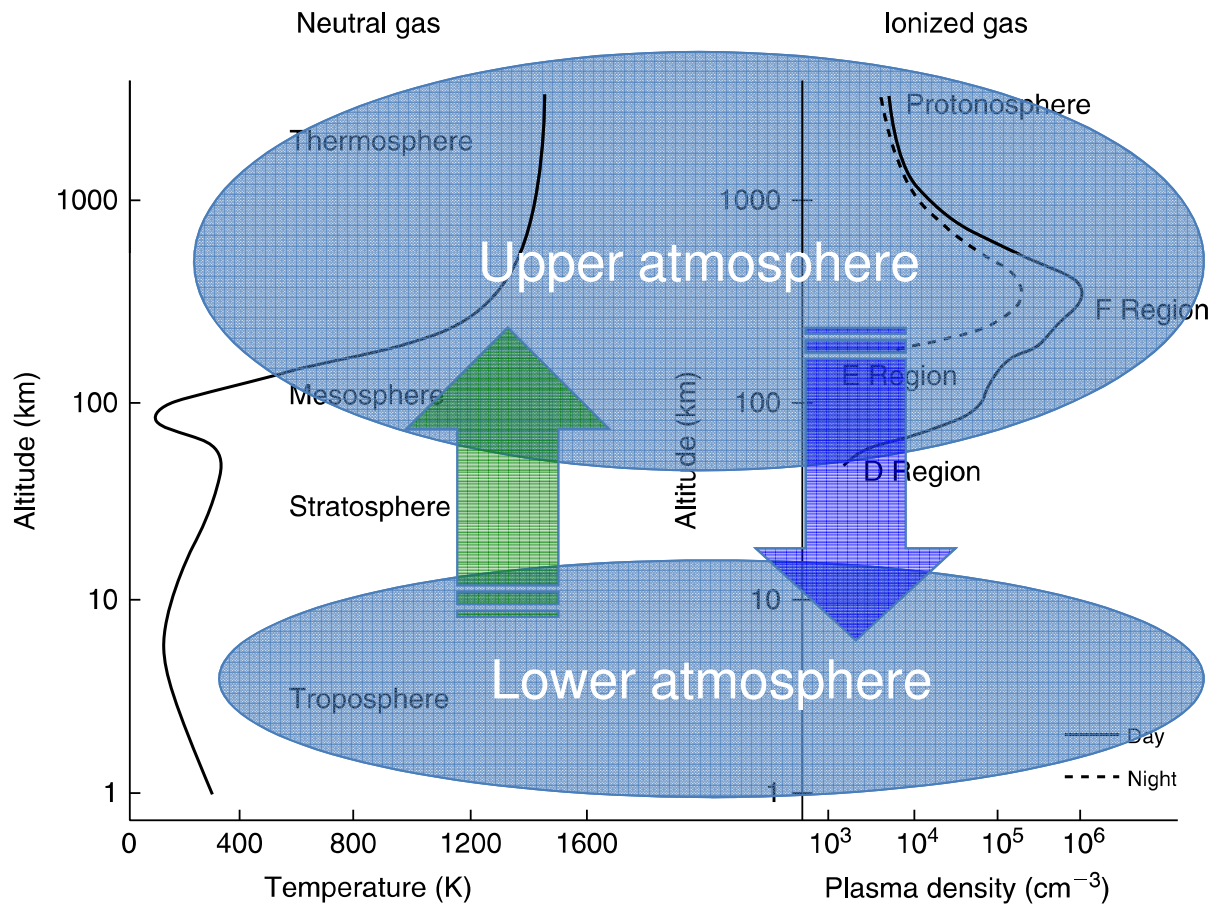
- **Mechanisms and coupling processes: How is the solar signal transferred down to the troposphere and surface?**
  - What is the relative importance between solar irradiance and energetic particle effects?
  - What are the impacts of cosmic rays on tropospheric chemistry, conductivity, and cloud formation?
  - What are the roles of the ocean and of the middle atmosphere in modulating the solar influence on climate?
  - How does solar forcing interact with the other sources of variability (ENSO, QBO, PDO, NAO, etc.)?
  - Which are the key mechanisms/feedbacks and what is still missing in atmospheric models?

# Working Group 1

## **Solar influence on climate: What are the uncertainties in establishing the long-term effect?**

- How can the solar signal be reliably extracted from observational records and model estimates?
- What are the regional impacts from solar variability?
- How well do climate models used in IPCC assessments represent both direct and indirect solar influence?
- How will the solar influence on climate evolve during this century?

# Working Group 2: Earth's atmosphere: Vertical coupling



# ROSMIC-CD: Key Science Questions

- What are the influences of lower atmospheric waves on the state and evolution of the thermosphere/ionosphere?

Wave coupling

- How atmospheric dynamics constrain electro-dynamics in the ionosphere?

Electrodynamic coupling

- How can we characterize significance of small scale structures for the large-scale features in the upper atmosphere?

Small scale dynamics



# Activities

- Intensive data analysis for specific periods/events
  - Solar Proton Events
  - GW Propagation into the Thermosphere
  - Lunar tides in ionospheric currents
- Inter-model comparisons
- Model observation comparisons
- Summer school

## Future Meetings

- Sessions/meetings in bigger conferences
  - COSPAR 2016, Istanbul
    - C2.2 Wave Coupling Processes and Consequences in the whole Atmosphere
  - ROSMIC workshop in August 2016?

# Working Group 3:

## Scientific collaboration/projects

### List of topics/teams and core group members in them

- **Winds:** MLT wind trends and changes of trends with time and latitude, and relationship to stratospheric and upper thermospheric wind trends (Jacobi, Qian, Venkat Ratnam, Lastovicka, Miyoshi) + **Waves:** Long-term trends in gravity waves and tides and their contribution to decadal trends in the middle atmosphere (Keckhut, Venkat Ratnam, Schmidt)
- **Temperature:** long term trend of the temperature in the middle atmosphere, lower and upper thermosphere (Venkat Ratnam, Keckhut, Miyoshi)
- **Heat budget and composition:** long-term changes and solar cycle influence in the heat budget and composition of the middle atmosphere (Mlynczak, Miyoshi, ?Schmidt, Marsh)
- **Sudden stratospheric warming (SSW):** impacts of SSWs on the general circulation in the MLT region and its trends, and on other middle atmosphere decadal trends (Miyoshi, Keckhut, partly Lastovicka, partly Marsh)

## Meetings

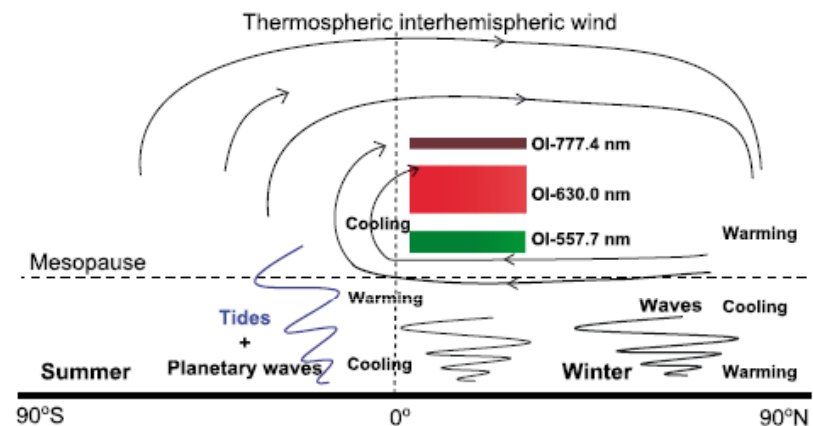
8th IAGA/ICMA/SCOSTEP workshop TREND2014 “Long-term changes and trends in the atmosphere”, Cambridge, July 2014, more than 50 participants. Very successful workshop in old historical College. Special issue of JGR is under preparation.

Symposium A15 “Long-term trends in the stratosphere, mesosphere, thermosphere and ionosphere” at IUGG 2015. 14 oral presentations (4 solicited) and 13 posters. Co-sponsored by SCOSTEP/VarSITI/ROSMIC.

Preparation of the 9th IAGA/ICMA/SCOSTEP workshop TREND2014 “Long-term changes and trends in the atmosphere”, Kühlungsborn, September 2016.

# Working Group 4

- A new program document called STARP (Solar Terrestrial Atmospheric Research Program) has been submitted to ISRO (Indian Space Research Organization) for consideration for support of VarSITI programs.

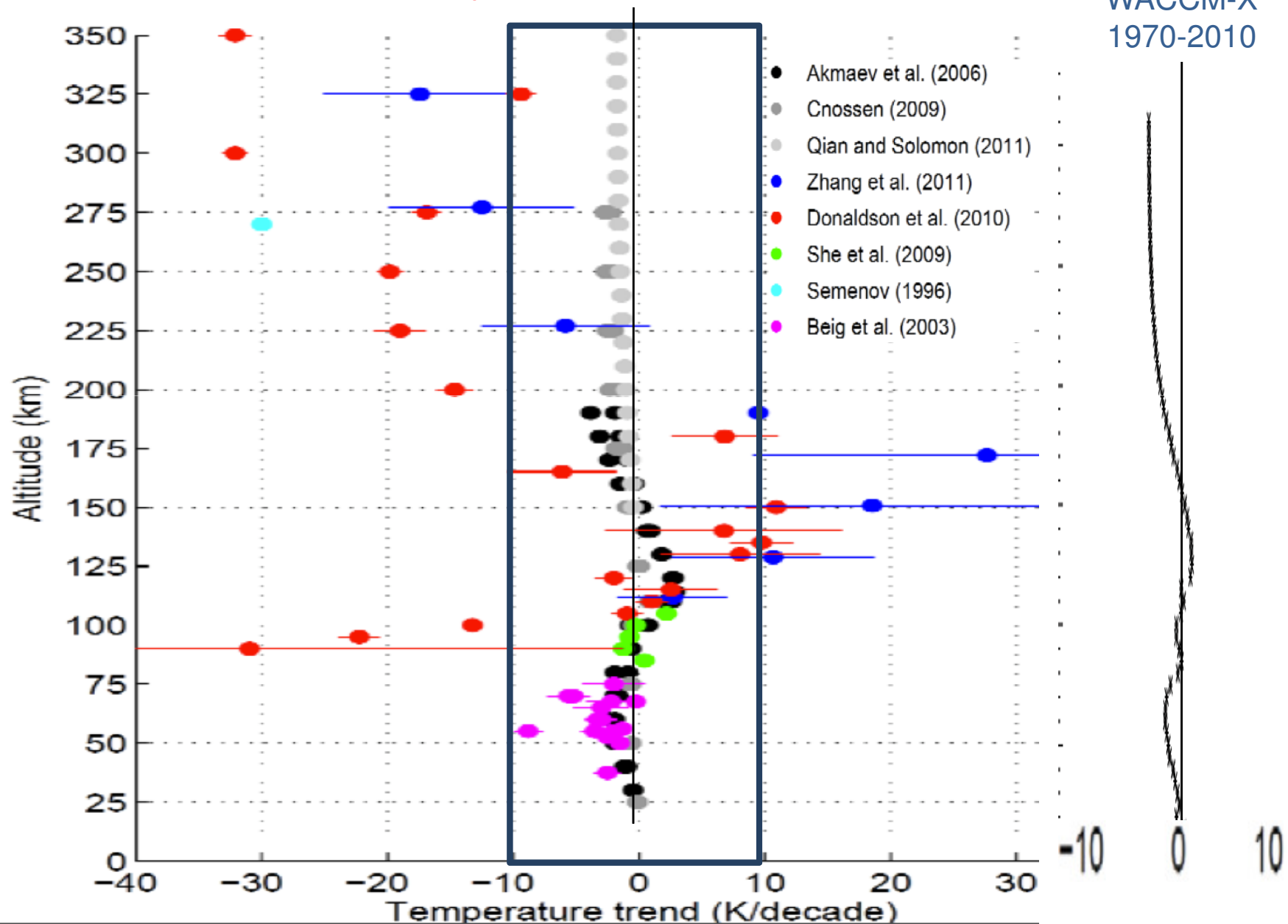


**Figure 7.** A simplistic schematic (not to scale) depicting the SSW-time additional meridional circulation cell that is proposed in the mesosphere-thermosphere system. The lines with arrowheads represent the direction and path of the winds. The dominant species in the lower thermosphere are transported with the wind through wind-induced diffusion. Due to this oxygen-rich air from high-to-low-latitude thermosphere, all the low-latitude thermospheric oxygen emission intensities show simultaneous enhancement. The horizontal color bars show the representative altitudes from where the oxygen emissions originate.

Laskar and Palamraju, 2014

# 1. Temperature trends derived from ISR are significantly larger than modeling and other observational results:

Crossen, 2012 Temperature Trends K/decade



# ROSMIC - Overall

- Proposed meeting in September 2016 in Kuelungsborn for all working groups.
- Activity has started on defining some campaign studies (Winter 2010, Winter 2015/2016) which would provide coordination and focus between the various working groups and linkages to the other VarSITI projects.