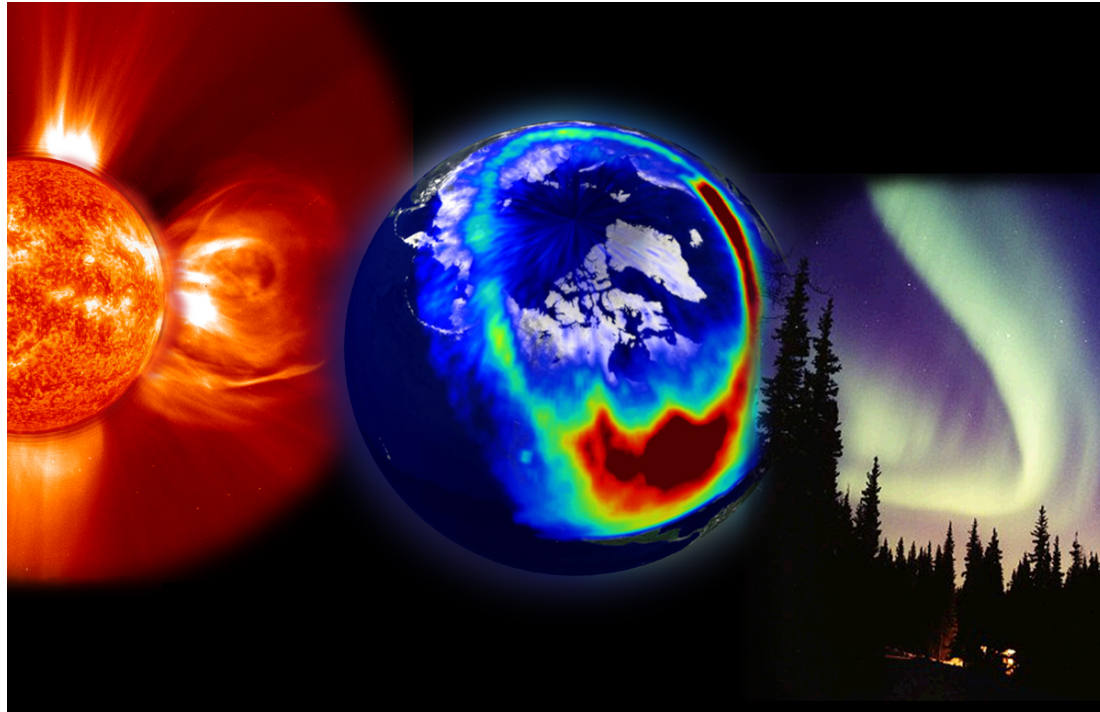


# Predictability of the variable Solar-Terrestrial Coupling



Ioannis A. Daglis



HELLENIC REPUBLIC

**National and Kapodistrian  
University of Athens**

— EST. 1837 —

# SCOSTEP

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- Loren Chang (National Central University, Taiwan)
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# SCOSTEP Next Scientific Program 2019-2024

- Drafted by 11-member committee  
(Argentina, China, Finland, France, Germany,  
Greece, India, New Zealand, Russia, Taiwan, USA)
- followed by open public consultation
- and by two ISSI Workshops (Beijing and Bern)  
with 22 additional participants



Choice of predictability theme  
as a unifying concept for coordinating  
research and outreach activities

*PreSTo:*

Predictability of the variable  
Solar-Terrestrial Coupling





国际空间科学研究所 - 北京

太空 | TAIKONG

ISSI-BJ Magazine

No. 13 June 2019

# PREDICTABILITY OF THE VARIABLE SOLAR-TERRESTRIAL COUPLING

## THE SCOSTEP NEXT SCIENTIFIC PROGRAM

**SCOSTEP**  
Scientific Committee on Solar-Terrestrial Physics





国际空间科学研究所 - 北京

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# PREDICTABILITY OF THE VARIABLE SOLAR-TERRESTRIAL COUPLING

THE SCOSTEP NEXT SCIENTIFIC PROGRAM

google “ISSI Beijing”

**SCOSTEP**  
Scientific Committee on Solar-Terrestrial Physics





# PRESTO - Predictability

Major motivation:

conduct fundamental research

that **has the prospect**

**to advance predictive capability**

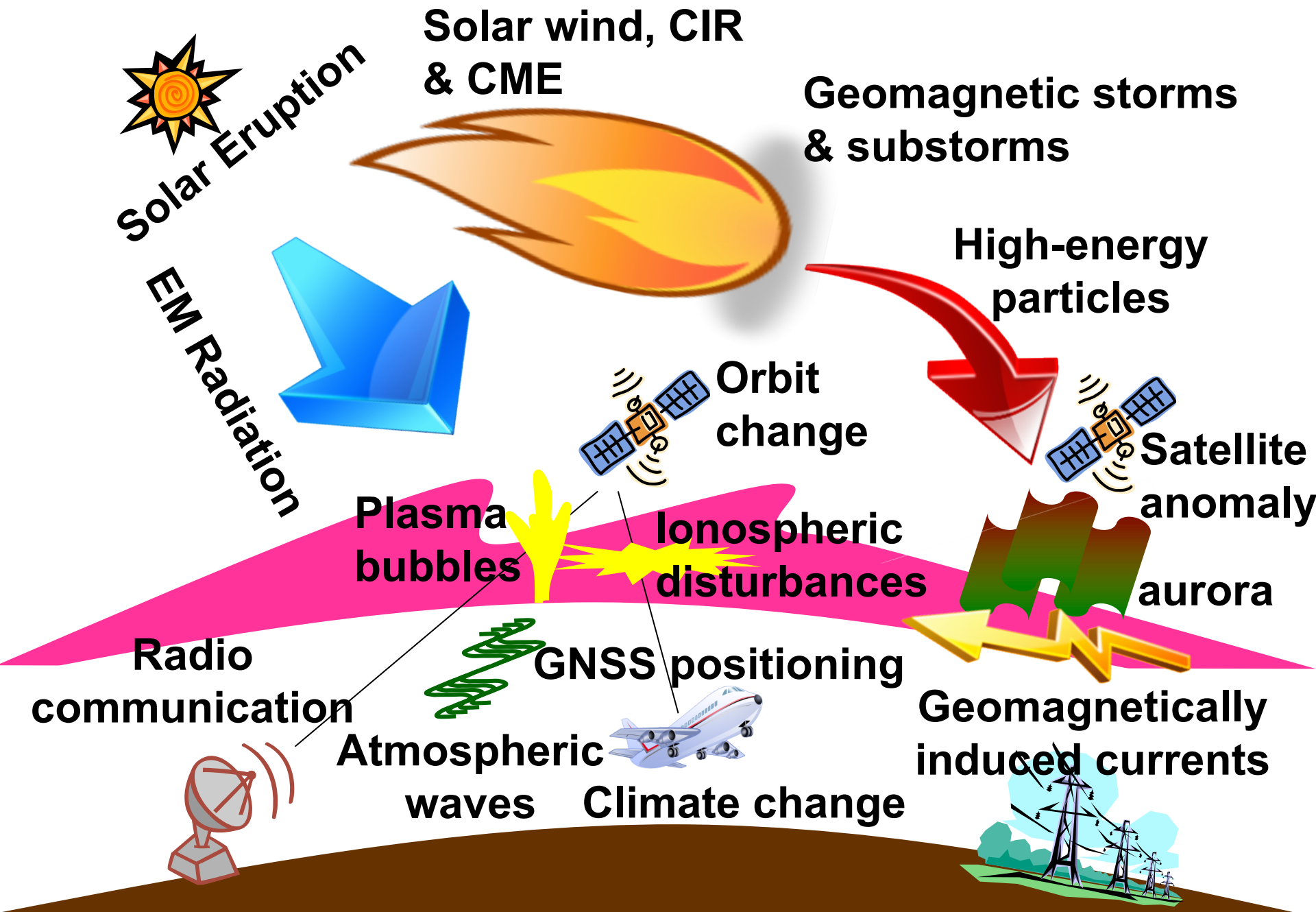
(societal implications)

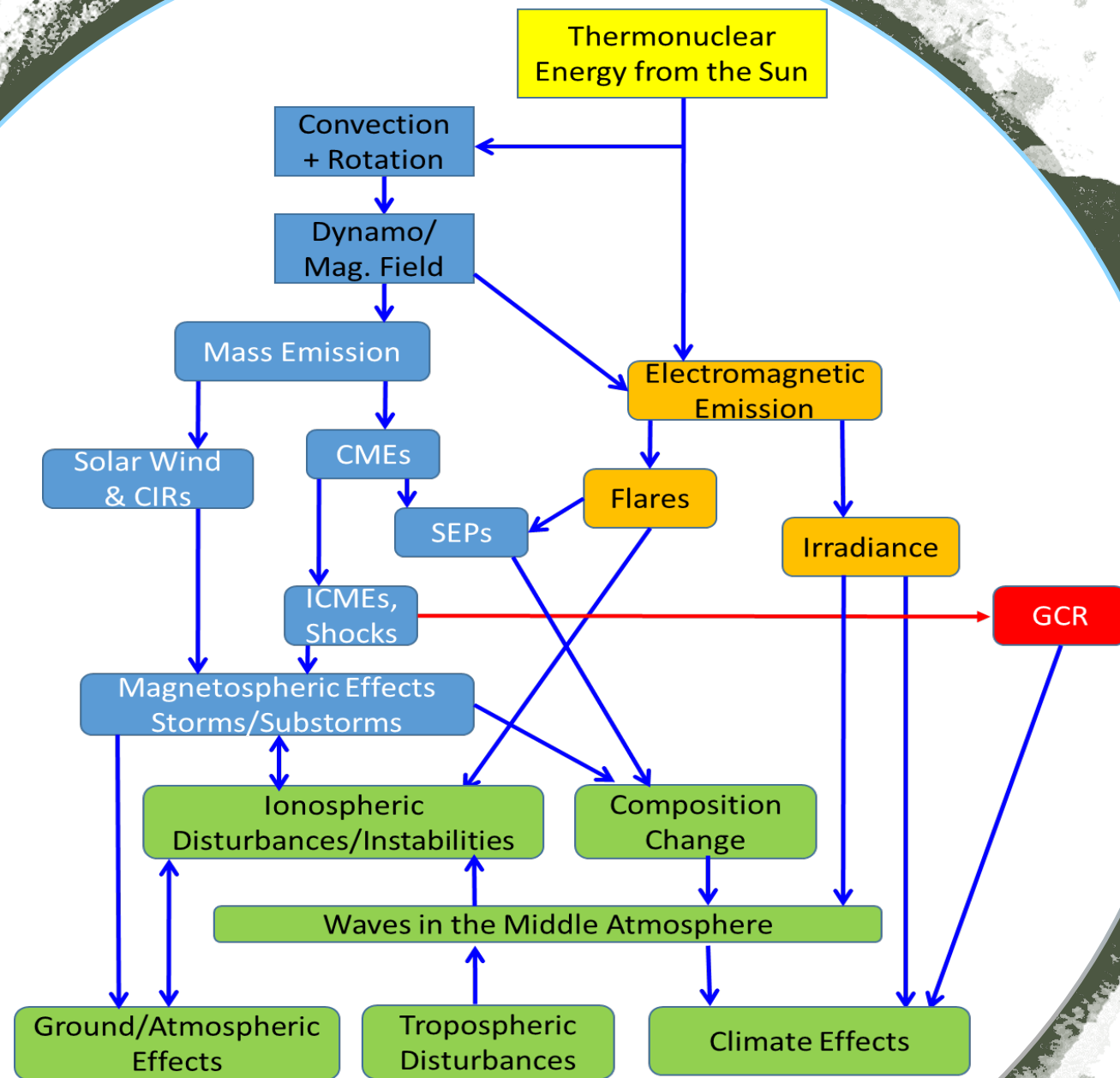
PreSTo: Predictability of the variable Solar-Terrestrial Coupling

# Predictability

- **timely scientific topic**
- **combines the interests of different topical communities**



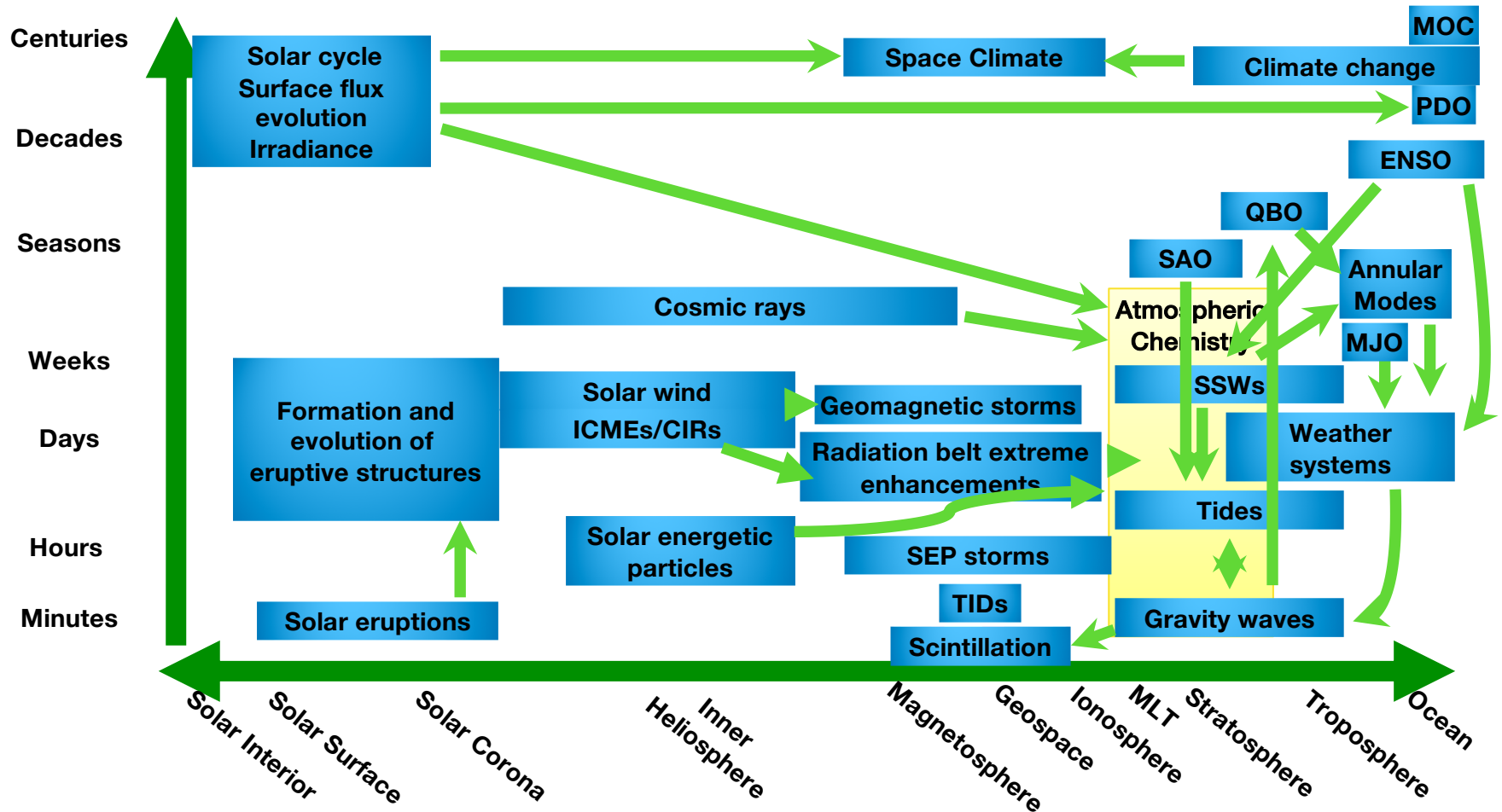






# An integrated view of solar-terrestrial coupling

Solar-terrestrial phenomena in various spatial & temporal scales



**PreSTo: Predictability of the variable Solar-Terrestrial Coupling**

# 3 pillars

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# 3 pillars

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## 1. Sun, interplanetary space and geospace



# 3 pillars

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1. Sun, interplanetary space and geospace
2. Space weather and Earth's atmosphere

# 3 pillars

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1. Sun, interplanetary space and geospace
2. Space weather and Earth's atmosphere
3. Solar activity and its influence on Earth's climate

# 3 pillars - 12 grand challenge questions

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1. Sun, interplanetary space and geospace

2. Space weather and Earth's atmosphere

3. Solar activity and its influence on Earth's climate



# 3 pillars - 12 grand challenge questions

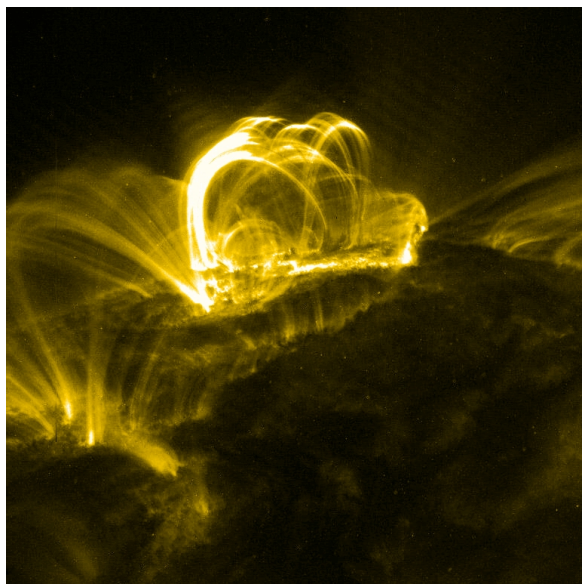
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## Pillar 1

Sun, interplanetary space and geospace

# Pillar 1: Sun, interplanetary space & geospace

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I.1. Conditions of solar eruptions genesis and reliable indicators of their inception

I.2. Model input parameters for successfully forecasting the arrival of SEPs and the geoeffectiveness of CMEs, SIRs/CIRs

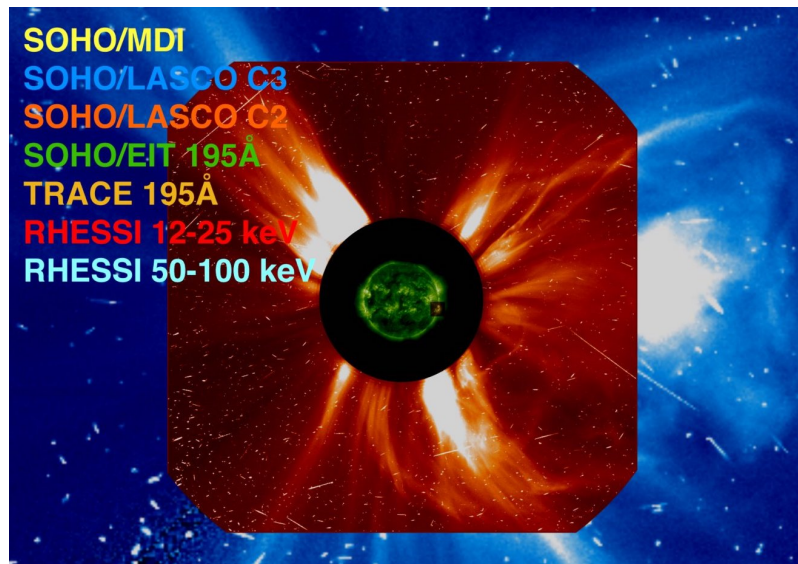
I.3. How are magnetospheric disturbances and waves driven by variable solar wind structures, and internal magnetospheric processes?

I.4. Predictability of storms, substorms and radiation hazards



# Pillar 1: Sun, interplanetary space & geospace

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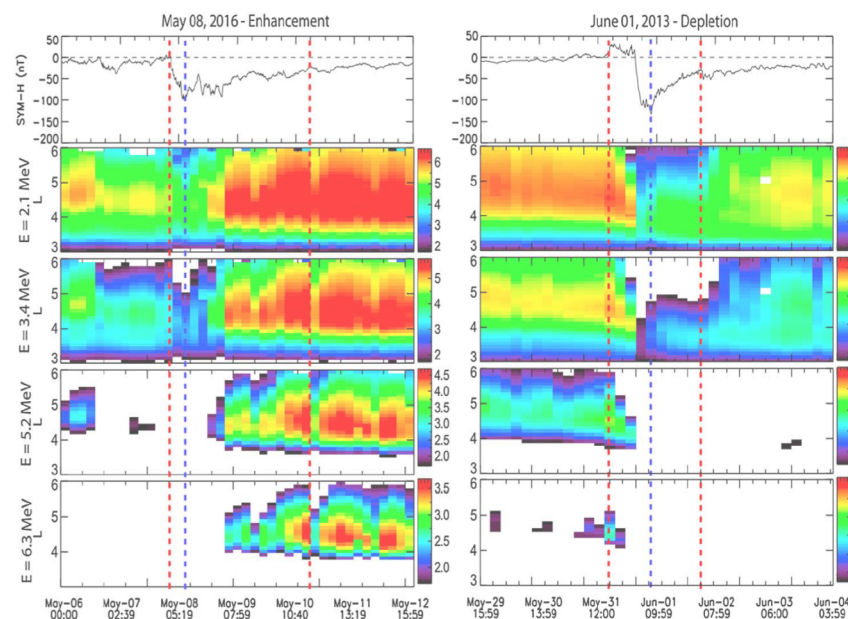
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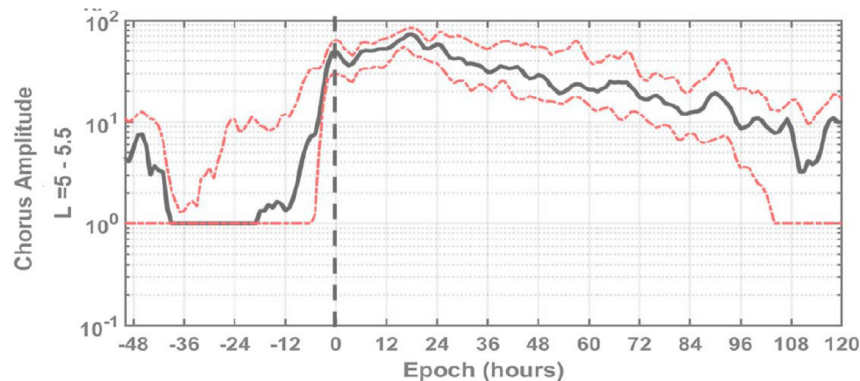
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# 3 pillars - 12 grand challenge questions

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## Pillar 2

Space weather and Earth's atmosphere

## Pillar 2: Space weather and Earth's atmosphere

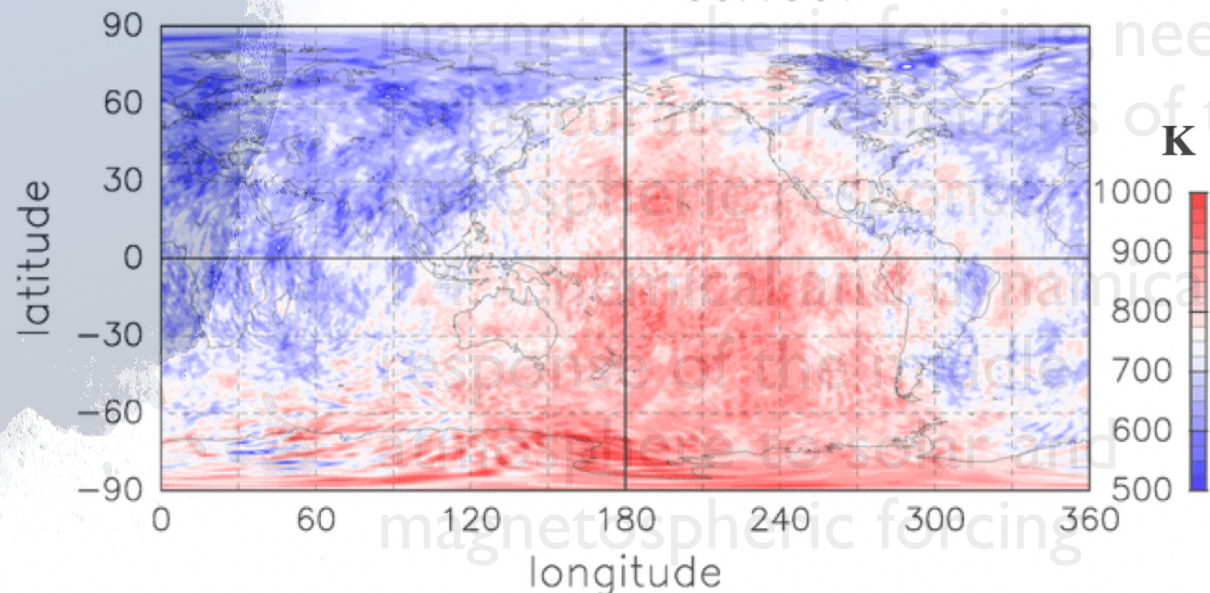
I.1. Response of thermosphere/ionosphere to forcing from above and from below

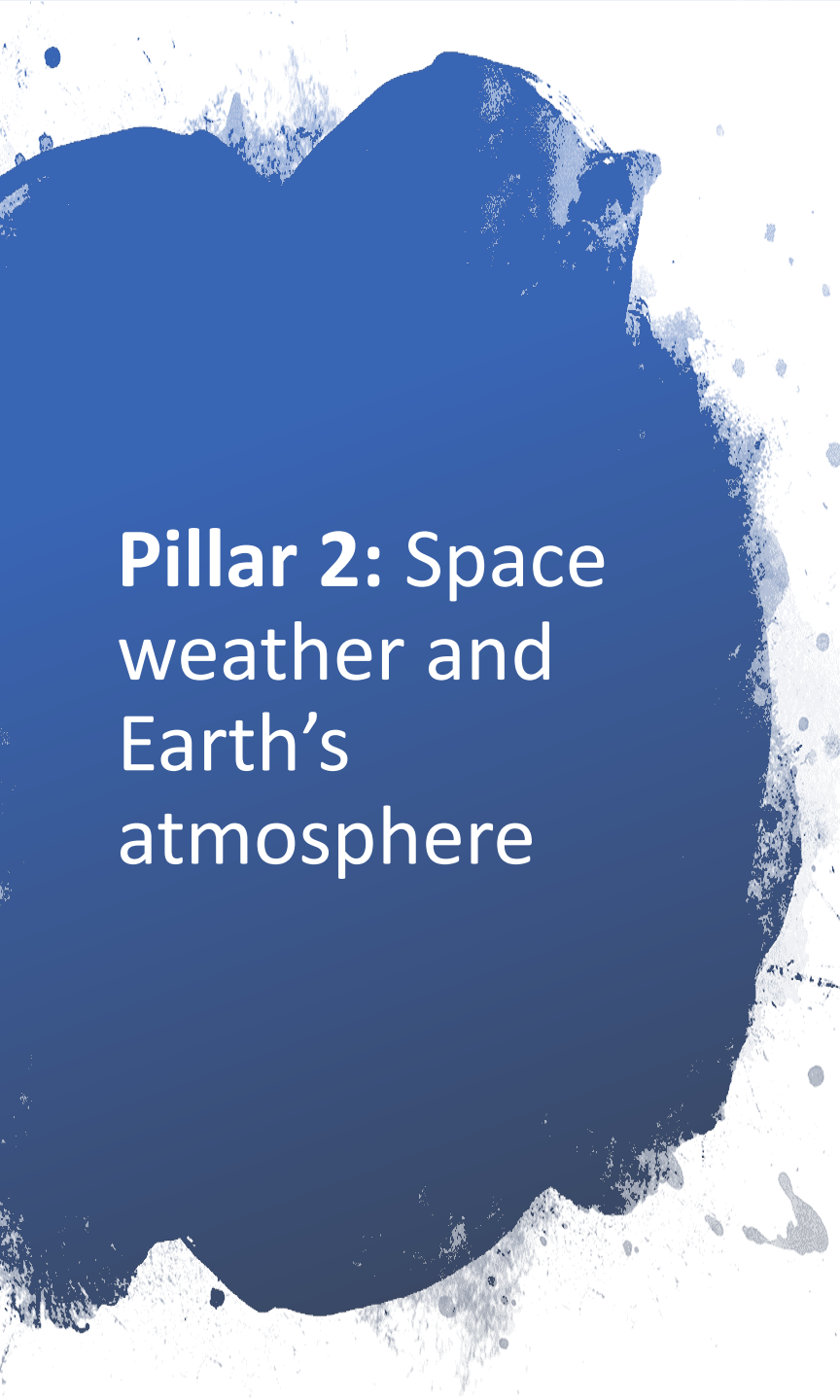
I.2. Impact of atmospheric waves and composition changes on middle and upper

### Temperature fluctuations associated with GWs

**Temperature at 400km (December Solstice)**  
(Solar minimum (F10.7=70) and geomagnetically quiet condition)

00:10UT





## **Pillar 2: Space weather and Earth's atmosphere**

I.1. Response of thermosphere /ionosphere to forcing from above and from below

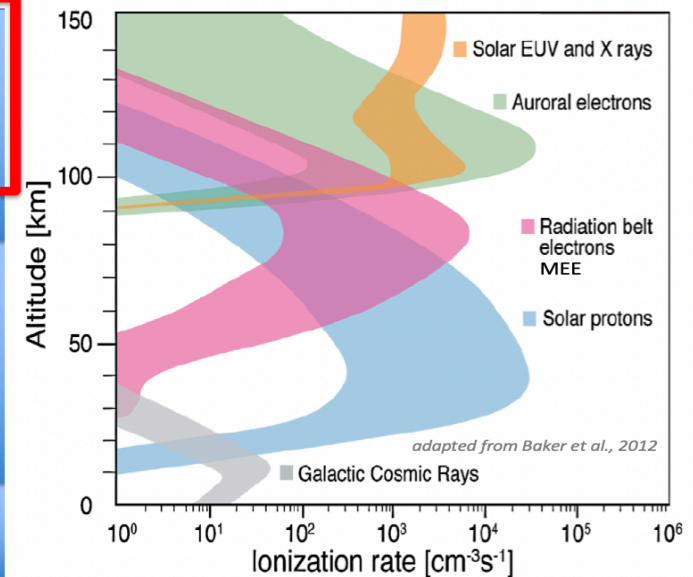
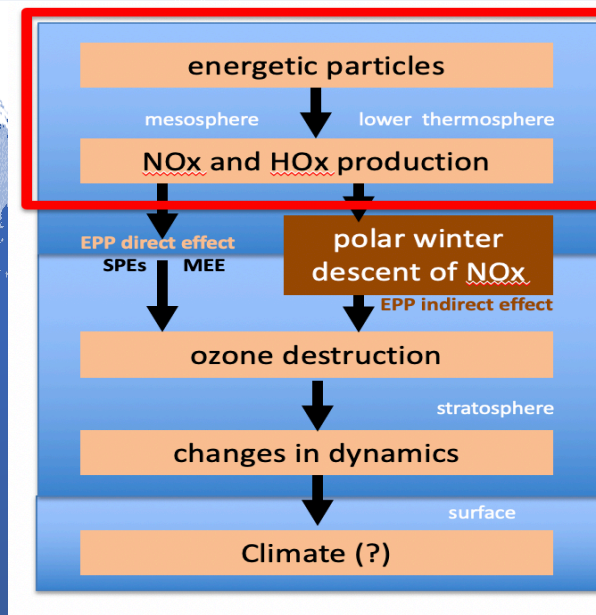
**I.2. Impact of atmospheric waves and composition changes on middle and upper atmosphere**

I.3. Magnitude and spectral characteristics of solar and magnetospheric forcing, needed for accurate predictions of the atmospheric response

I.4. Chemical and dynamical response of the middle atmosphere to solar and magnetospheric forcing



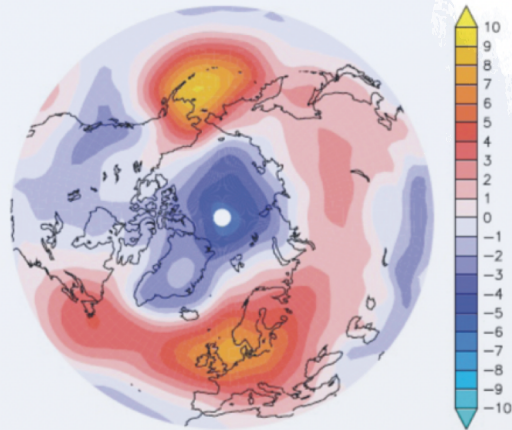
## Pillar 2: Space weather and Earth's atmosphere



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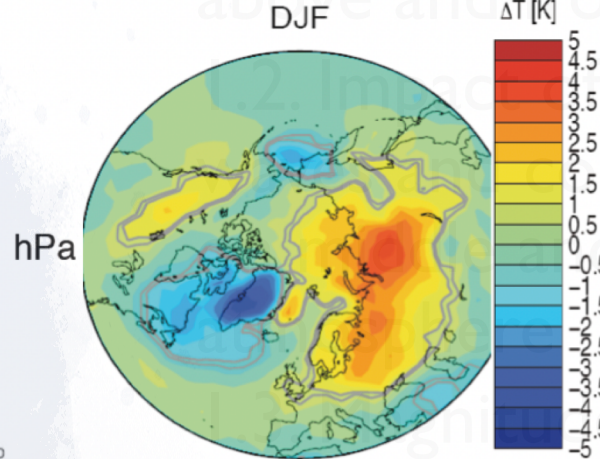
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EMAC, DJF surface  
press. changes (EPP-  
no EPP), no SSW years



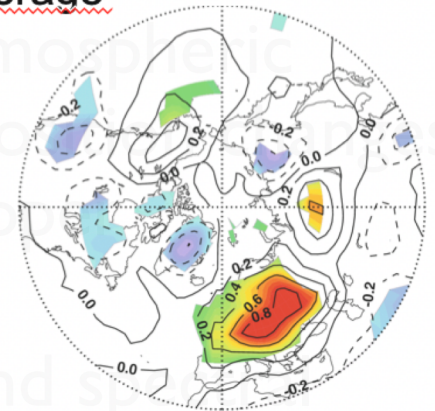
Baumgaertner et al., 2011

NCEP reanalysis, DJF  
surface T changes  
(high Ap – low Ap)



Seppälä et al., 2009

SOCOL, surface temp.  
changes (EPP-no EPP),  
1960-2010 annual  
average



Rozanov et al., 2012

## Pillar 2: Space weather and Earth's atmosphere

magnetospheric forcing, needed  
for accurate predictions of the  
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- I.4. Chemical and dynamical  
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magnetospheric forcing

# 3 pillars - 12 grand challenge questions

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## Pillar 3

**Solar activity and its influence  
on Earth's climate**

# 3 pillars - 12 grand challenge questions

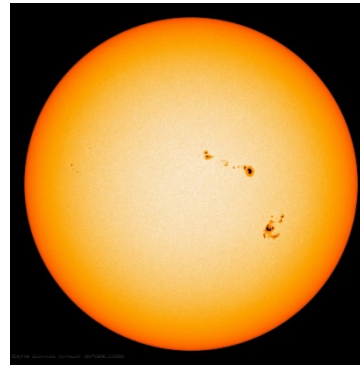
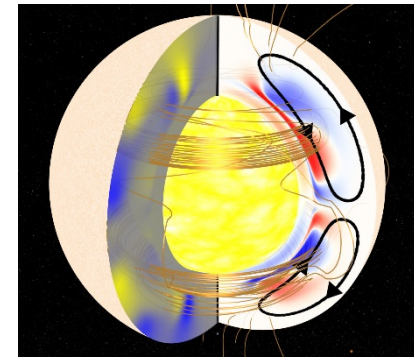
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## Pillar 3

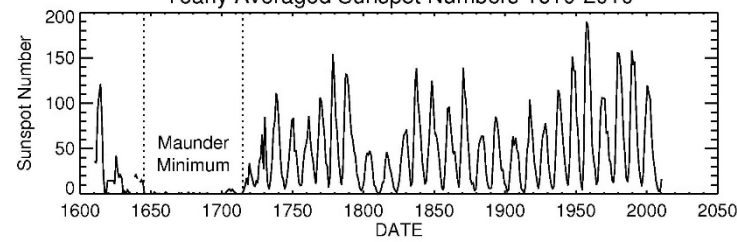
Solar **climate** and its influence  
on Earth's climate



## Solar dynamo



Yearly Averaged Sunspot Numbers 1610-2010



Solar energetic particles      Magnetospheric particles

Interplanetary space

Magnetosphere

Ionosphere  
Thermosphere

Mesosphere

Stratosphere

Troposphere

Total solar irradiance (TSI)

UV emission

Energetic particle precipitation

Chemical-dynamical coupling

Ozone  
Temperature

Dynamical coupling

Atmospheric oscillations

Anthropogenic effects

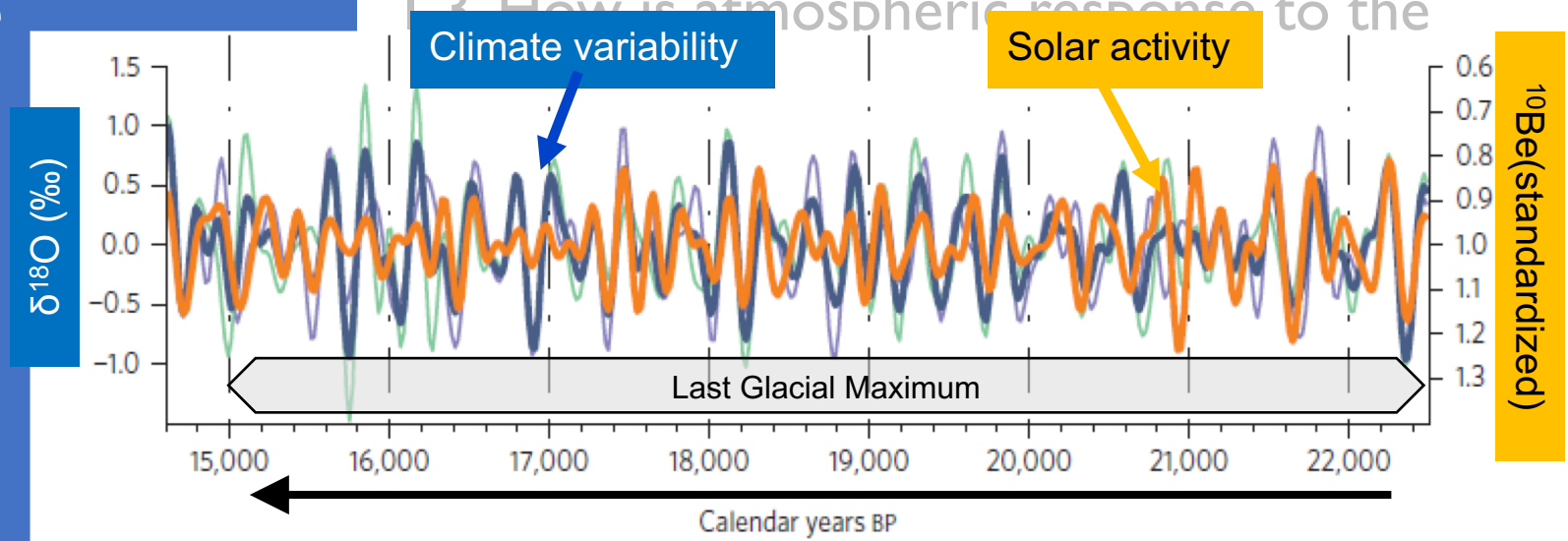
Sea surface temperature variability

# Pillar 3: Solar activity and its influence on Earth's climate

1.1. How will future solar activity vary over timescales relevant for the forcing of the Earth's climate and atmospheric dynamics?

1.2. What is the role of coupling between atmospheric regions in the realization of the long-term solar influence?

1.3. How is atmospheric response to the



## **Pillar 3:** Solar activity and its influence on Earth's climate

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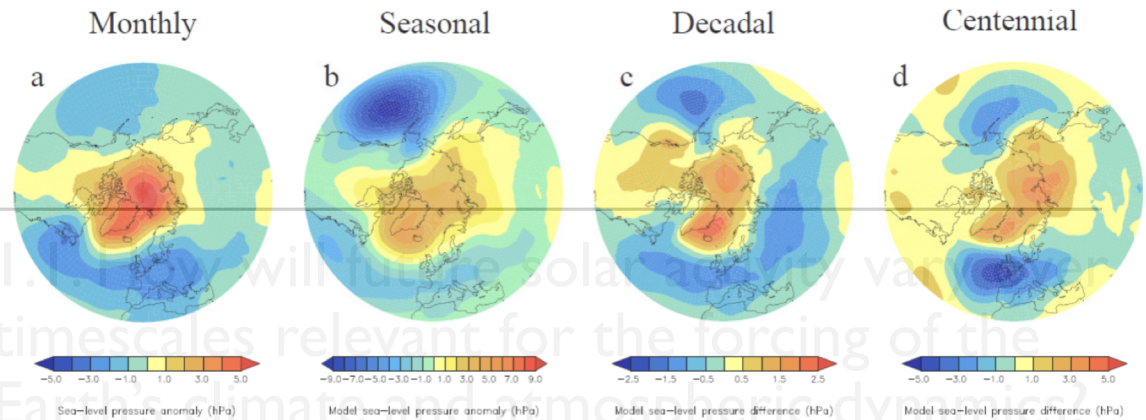
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Choice of predictability theme  
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*PreSTo:*

Predictability of the variable  
Solar-Terrestrial Coupling

# Predictability

deterministic predictions

vs

probabilistic predictions



# Predictability

sophisticated models

VS

simple models



Thank you!

Merci!