

L4+L5 Mission as an Ideal Project for International Collaboration

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Abstract

Having satellites positioned in-orbit at both Lagrangian L5 and L4 points offers several major advantages. For example, the L5 vantage point provides an early view of the solar surface, which Earth will be facing 4-5 days later. In turn, the L4 viewing point enables a better view of the source regions of eruptions responsible for SEPs affecting the near-Earth environment. Taken together, observations from L4 and L5 cover about 83% of solar surface, which will significantly improve both short- and long-term forecasts. However, in the most likely scenario that funding will support only a single L5 mission, not both, one alternative that the space weather community may want to explore is to encourage other spacefaring nations such as Russia, China, and India, to launch their own spacecraft to L4 in close coordination with the L5 mission. Launching two separate spacecraft to L4 and L5 will allow us to reap the benefits of having two new vantage points for space weather in addition to the L1 vantage point, to more-fully share the costs of such combined missions, and avoid the restrictions related to the transfer of technology (predominantly affected the L5 and L1 concepts to date).

What Do Some Other Spacefaring Nations Plan for L5?

- China
 - L5 mission was proposed to the Chinese Space Science Priority Program; could consider L4 as China's contribution to the international project, and could also contribute to the ESA L5 mission in terms of instruments, launch and in particular Chinese DSN.
- India
 - Aditya - L1 mission (launch in 2019 – 2020)
 - There is a considerable interest from Indian scientists for L5 mission and a white paper is under the review at ISRO (Indian Space Research Organisation).

Aditya –L1 Instruments

- **Visible Emission Line Coronagraph (VELC):** (3 visible and 1 Infra-Red channels); magnetic field measurement of solar corona
- **Solar Ultraviolet Imaging Telescope (SUIT):** near Ultraviolet (200-400 nm), solar irradiance
- **Aditya Solar wind Particle Experiment (ASPEX)**
- **Plasma Analyser Package for Aditya (PAPA):** solar wind composition
- **Solar Low Energy X-ray Spectrometer (SoLEXS)**
- **High Energy L1 Orbiting X-ray Spectrometer (HEL1OS)**
- **Magnetometer**

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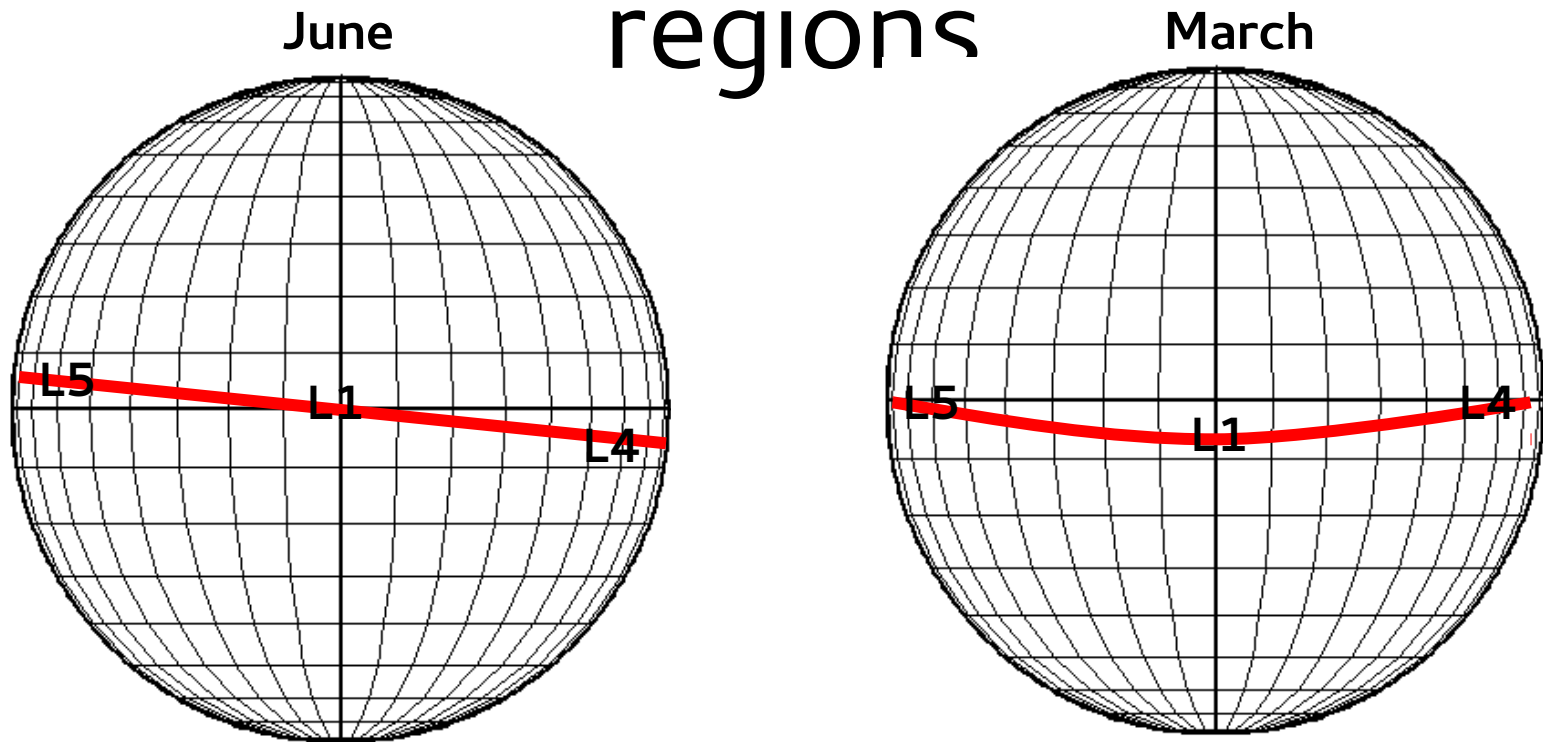
- Russia

- L4+L5 project originates from the Interplanetary Solar Stereoscopic Observatory (ISSO) □ Orbital Stellar Stereoscopic Observatory (OStSO)
- Some interest from the Russian Academy of Sciences; the OStSO project is under evaluation at ROSCOSMOS (Russia's Space Agency).

Instead of having multiple L5 missions, should we aim at L1-L5 and L4?

- L5 – early view of solar surface, which Earth will be facing 4-5 days later
- L4 – a better view of source regions of eruptions responsible for SEPs affecting the near-Earth environment.
- L4+L5 will cover about 83% of solar surface and significantly improve both short- and long-term forecasts.
- L4+L1+L5+Flux transport (ADAPT) would provide very realistic representation of magnetic flux of entire solar surface.
- Other benefits: better polar field, CME triangulation, CME speed and direction, etc.

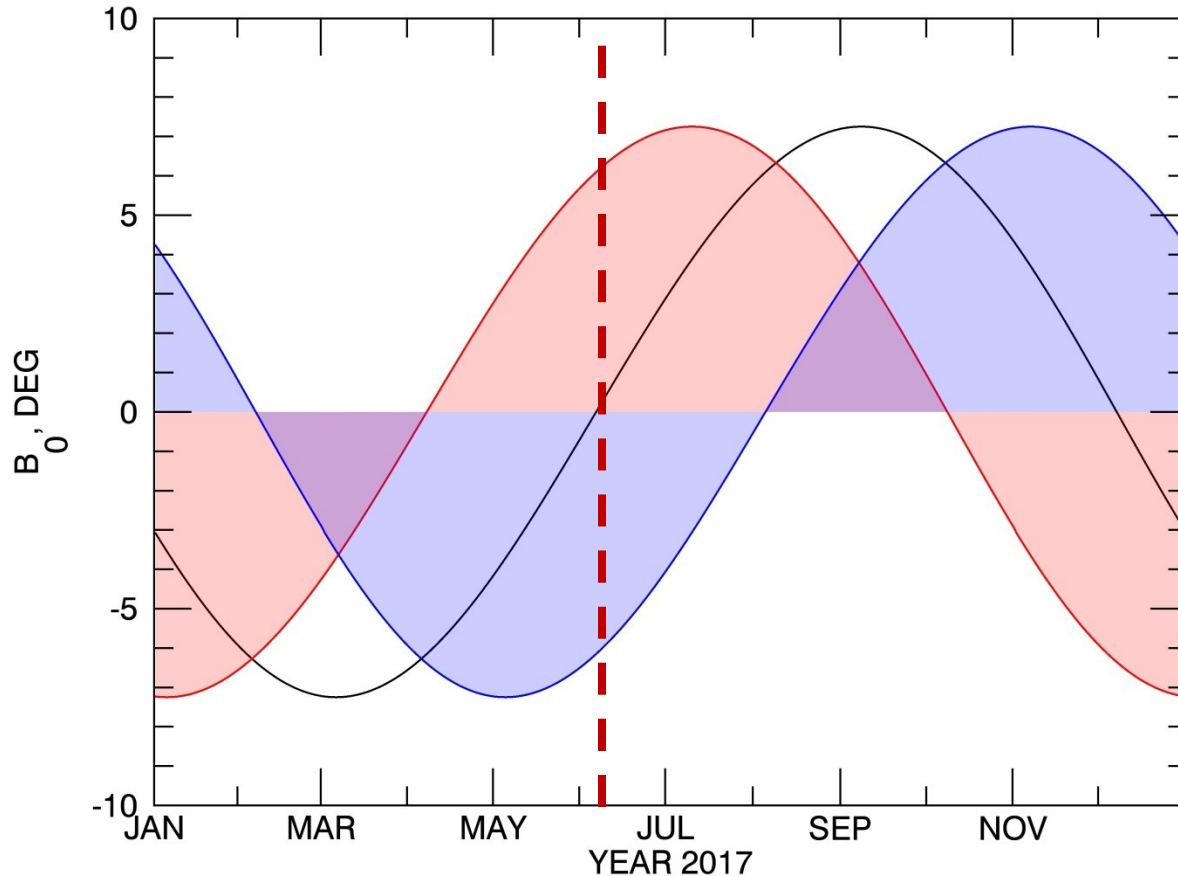
Example: L5-L1-L4 have different vantage to polar regions



(red) Plane of Earth orbit inclined to about 7 degrees to solar equator

Polar Field from L1-L5-L4

Latitude of solar disk center from L5 (red), L1 (black), and L4 (blue)



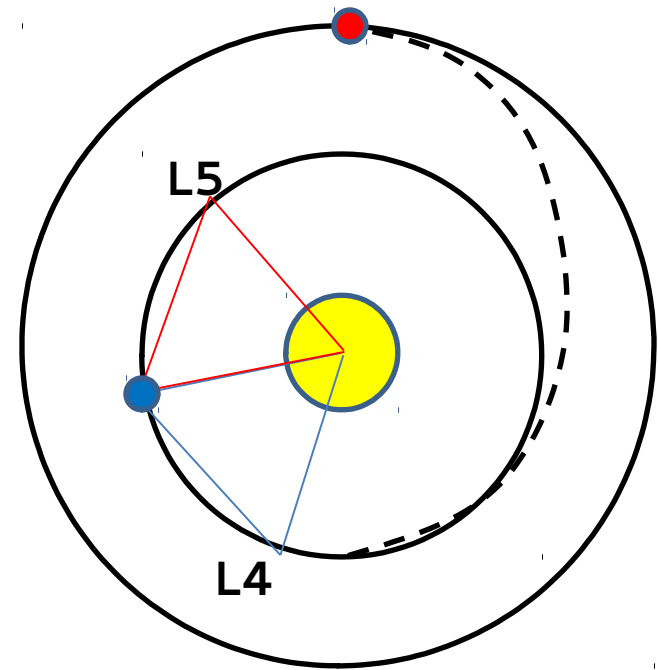
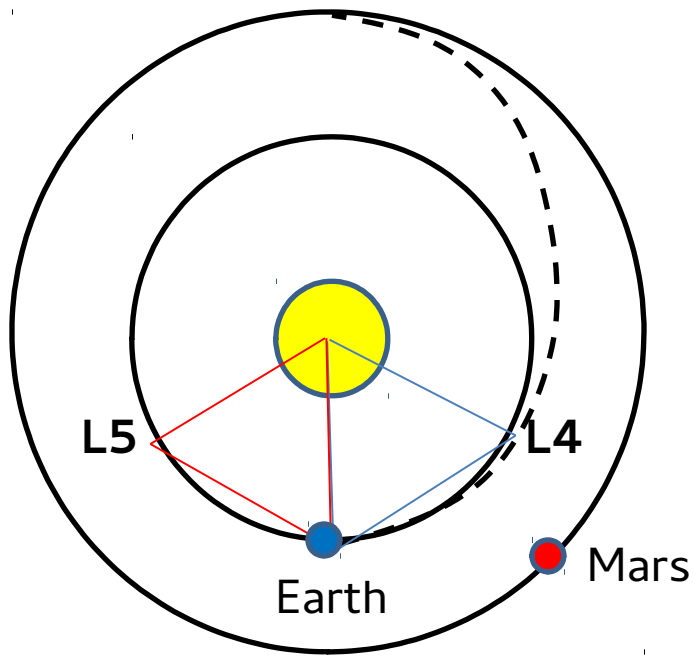
- Knowledge of polar fields is critical for many SW models (e.g., PFSS, WSA-Enlil).
- Combination of L1, L5 and L4 will improve polar field representation.

Role of L4-L5 for Mars Expedition

30 April 2018
Depart Earth

+260 days

15 Jan 2019
Arrive Mars



It is unlikely that ESA-(NASA-NOAA) will fund L4 (in addition to L1 and L5)

- Possible solution: to encourage other spacefaring nations such as China, India, Russia to launch their own spacecraft to L4 in close coordination with the L5 mission.
- Advantages:
 - Having L5-L1-L4 would have a huge mutual benefit
 - Costs are more-fully shared; minimal inter-dependency
 - Avoids “usual” restrictions on transfer of technology (EAR, ITAR)
 - Strong international collaboration in critical area
 - Will provide very positive public and political visibility to the field
- Requires political will to initiate such collaboration: willingness to share/coordinate requirements for key instruments, establishing clear rules about sharing the data, etc. – this needs to happen soon