Seasonal cycle of methane on Mars could be produced by variations of the Hadley cell and differential hemispheric releases

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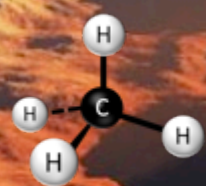

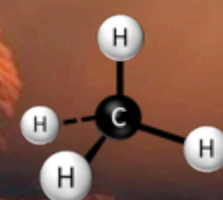

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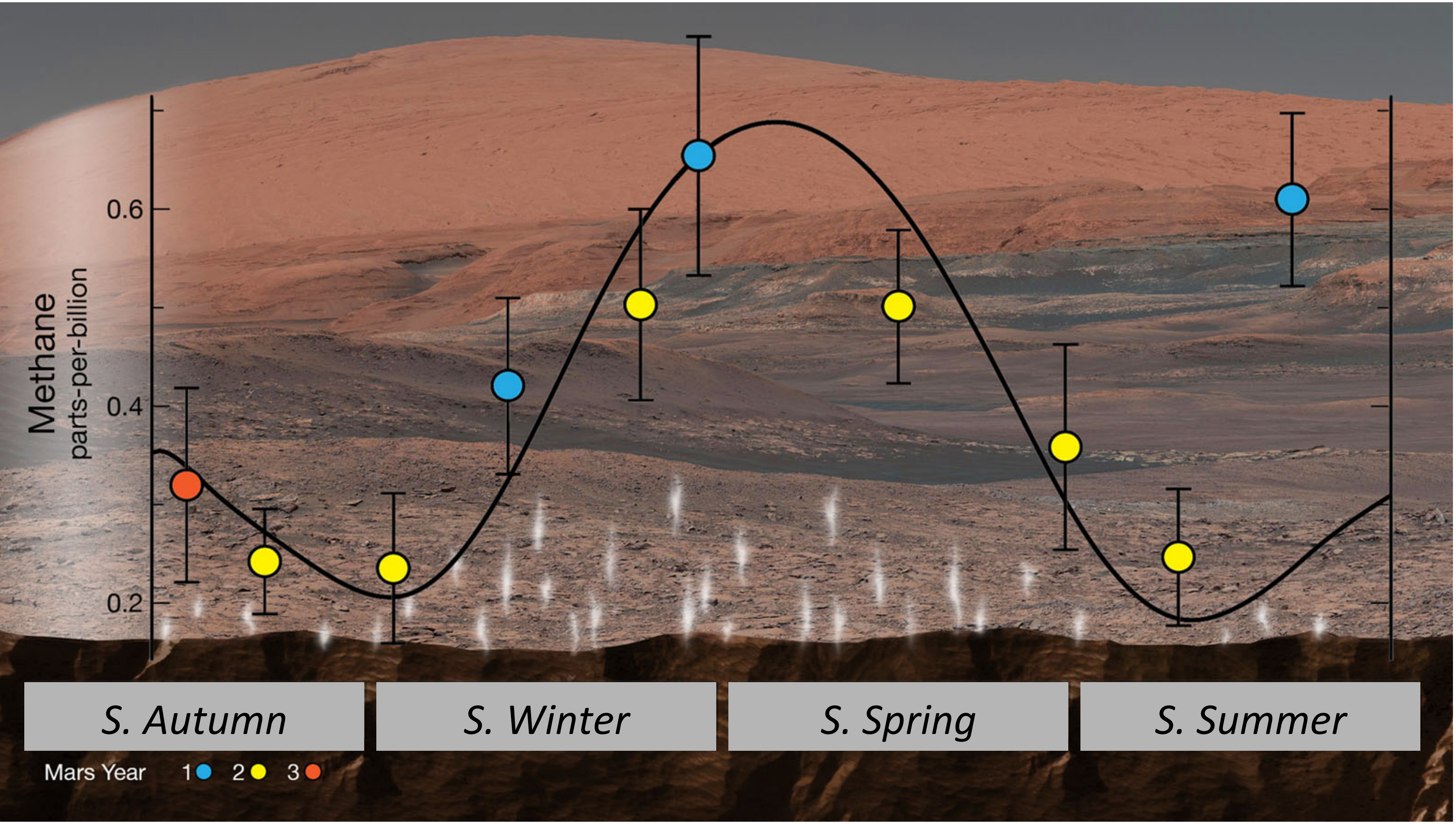
Background levels of methane in Mars' atmosphere show strong seasonal variations
Webster et al. 2018

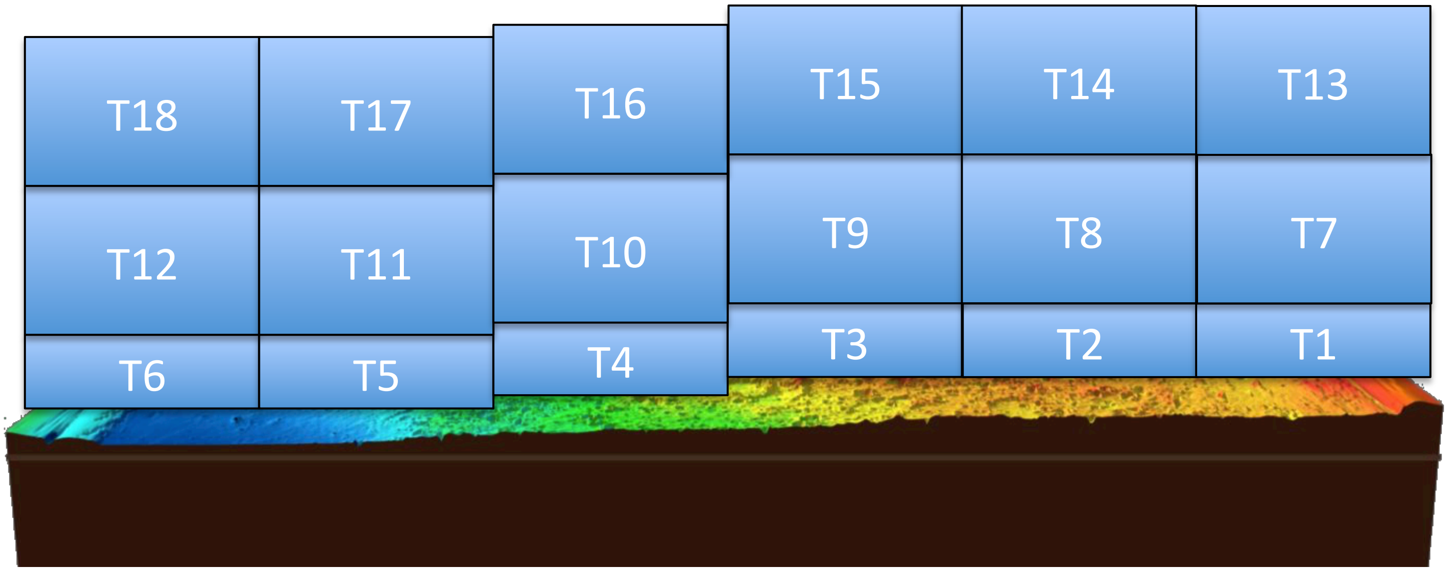


Mars Global circulation studies using (18) pasive tracers in MRAMS atmospheric transport experiments

T1-T6: 0-10 km above ground level

T7-T12: 10-30 km above ground level

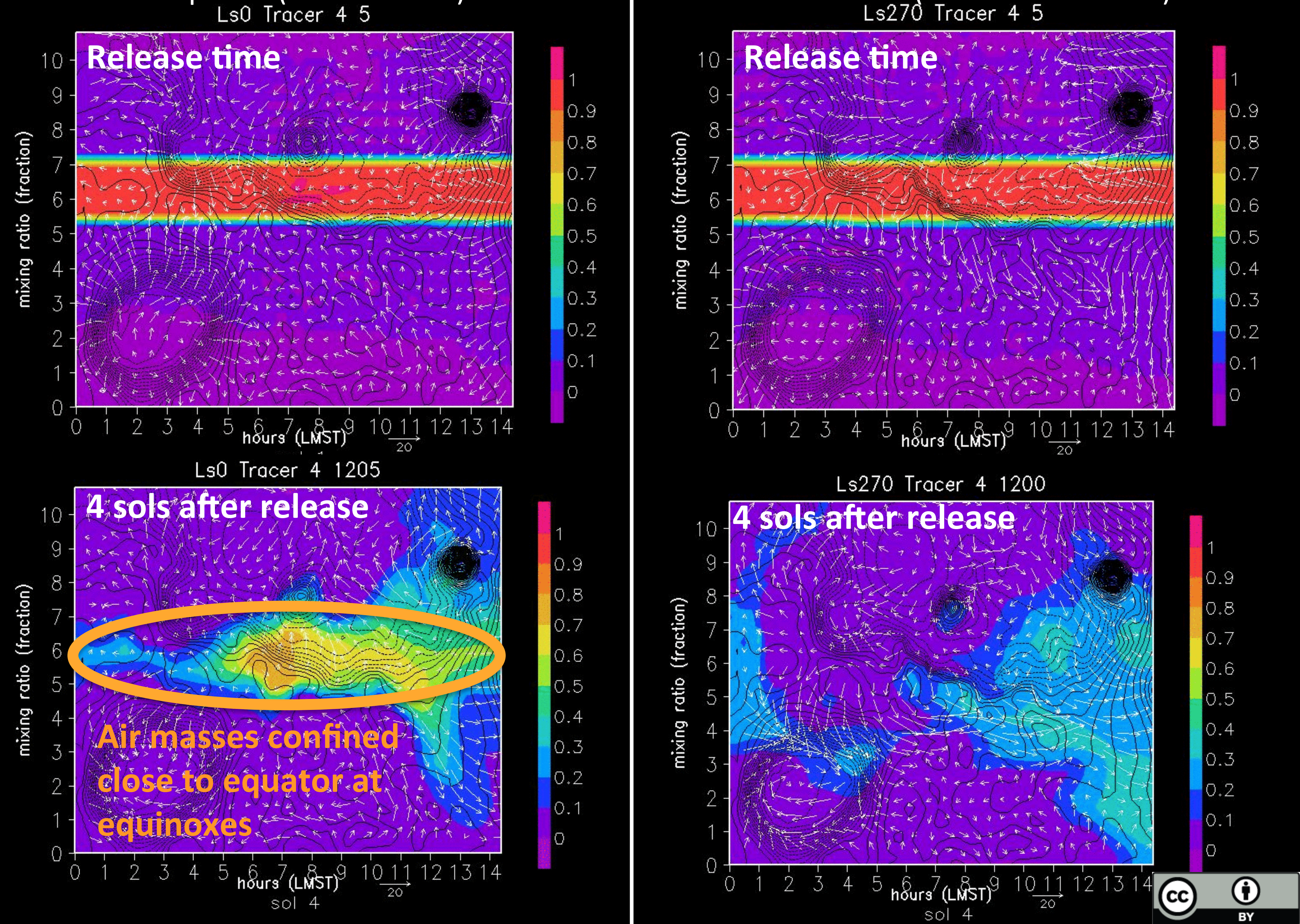
T13-T18: 30-50 km above ground level



Global slice of the martian topography along 0° E longitude (MGS)

Modeling results

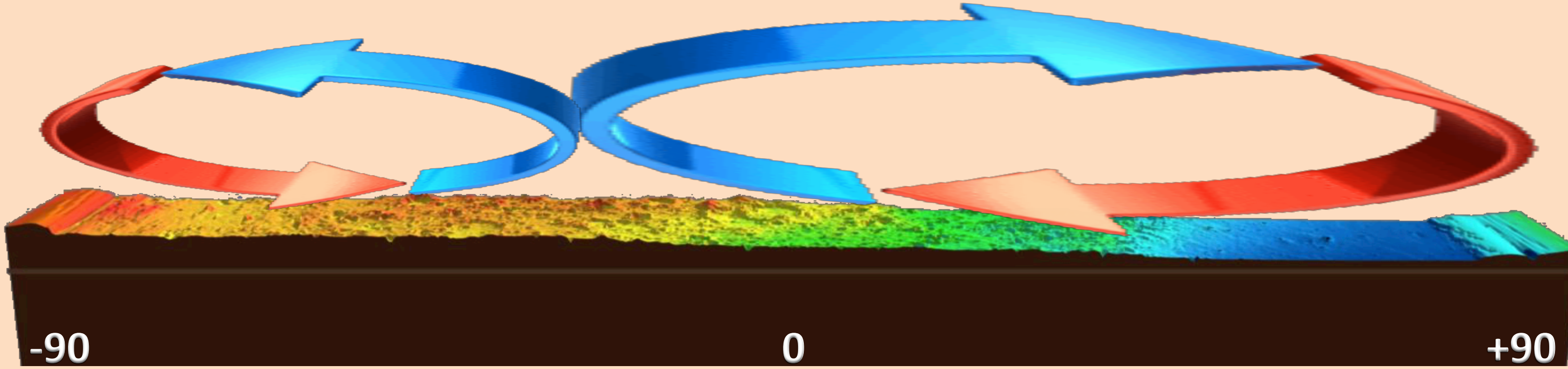
Equinox (southern fall) | Solstice (southern summer)



Seasonal variations of the Hadley cell impacts transport of trace gases to Gale

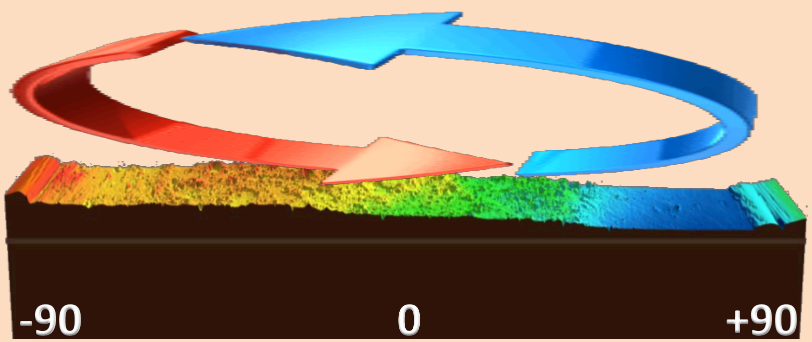
(based on MRAMS global tracers experiments, *Pla-García et al. 2020, tbs*)

Equinoxes (L_s 0° & L_s 180°)

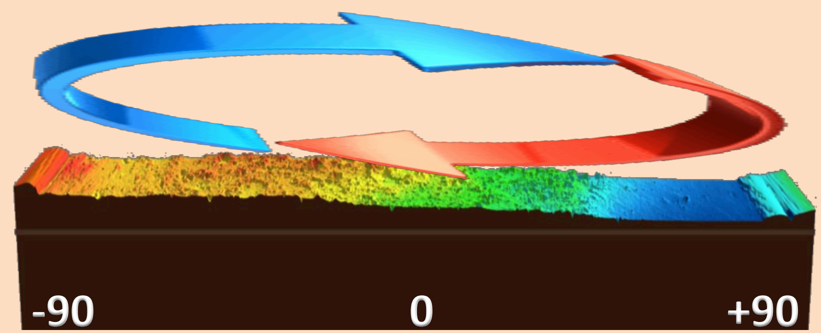


Dual Hadley cells with air rising near the equator being fed by surface flow from both hemispheres helps to confine air masses close to Gale crater.

L_s 90°solstice



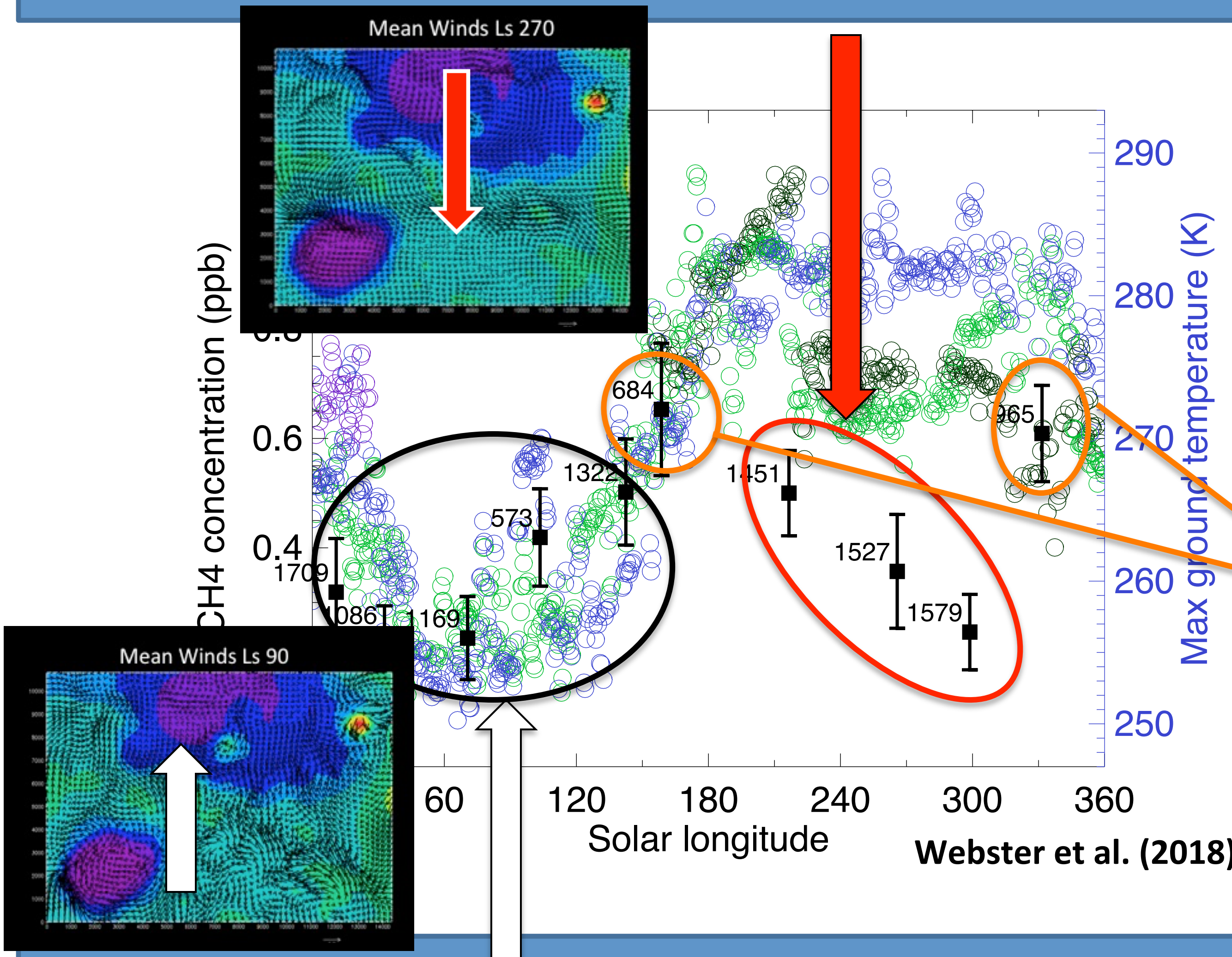
L_s 270°solstice

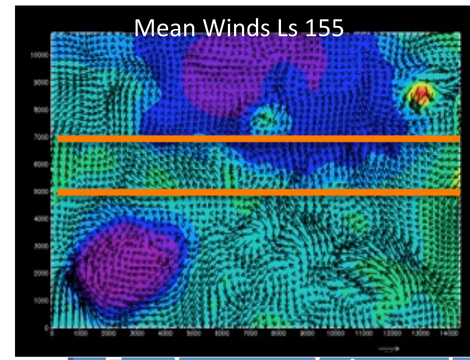


Global Hadley Cell drives air coming in straight from high latitudes of the winter hemisphere almost undiluted replacing Gale air masses.

Seasonal variations of the Mars Hadley cell and CH_4 release may drive the seasonal CH_4 cycle at Gale Crater

CH_4 rich (warmer seasons at Gale) internal crater air is being rapidly replaced with a wholesale inundation of *-putative-* CH_4 poor external crater air from the **NORTHERN** winter hemisphere





Equinoxes: internal crater air is mixed with external crater air from more **tropical** regions. **AIR MASSES ARE BEING CONFINED CLOSE TO EQUATOR**

CH_4 poor (cooler seasons at Gale) internal crater air is mixed with *–putative-* CH_4 poor (cooler seasons close to Gale) external crater air from the **SOUTHERN** winter hemisphere

Conclusions

- Strong correlation between atmospheric CH_4 values and ground temperature at Gale during most of the year <u>**except during Ls216-298**</u>.

- If methane release is related to ground temperature, then we can assume that the cold polar regions have lower emissions and will tend to be methane poor.

- Placement of latitudinally initialized tracers to test the hemispheric transport hypothesis.

- The circulation during <u>**Ls216-298**</u> transports cold, north polar air into Gale. This should result in methane concentrations that are lower than what would be expected based on the local ground temperature.

- At equinoxes, the source of air in Gale is more tropical, and thus the methane concentrations should roughly track the local ground temperature.

- <u>The seasonal change in the global circulation (winds) combined with seasonal changes in the hemispheric release of CH_4 (temperature dependent subsurface emissions) ***could*** produce a seasonal CH_4 signal at Gale</u>.