The evolution of speech

- Humans uniquely have a complex oral communication capability based on speech and speech recognition.
- This trait has allowed our species to rapidly communicate information without resorting to genetic selection
- Has speech allowed humans to escape the Red Queen contraint?
- The biology of speech

The Foxp2 gene – A gene for the evolution of language?

- MMQESATETISNSSMNQNGMSTLSSQLDAGSRDGRSSGDTSSEVSTVELL
HLQQQQALQAARQLLLQQQTSGLKSPKSSDKQRPLQVPVSVAMMTPQVIT
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LQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQQHPGKQAKE
QQQQQQQQQLAAQQLVFQQQLLQMQQLQQQQHLLSLQRQGLISIPPG
QAALPVQSLPQAGLSPAEIQQLWKEVTGV
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{N}TSKASPPITHHSIVNGQSSVL{S}
ARRDSSSHEETGASHTLYGH
<GVCKWPGCESICEDFGQFLKHLNNEH>
ALDDRSTAQCRVQMQVVQQLEIQLSKERERLQAMMTHLHMRPSEPKPSPK
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VGAIRRRHSDKYNIPMSSEIAPNYEFYKNADV
[RPPFTYATLIRQAIMESSDRQLTLNEIYSWFTRTFAYFRRNAATWK
NAVRHNLSLHKCFVRVENVKGAVWTVDEVEYQKRRSQKITGSPTL]
VKNIPTSLGYGAALNASLQAALAESSLPLLSNPGLINNASSGLLQAVHED
LNGSLDHIDSNGNSSPGCSPQPHIHSIHVKEEPVIAEDEDCPMSLVTTAN
HSPELEDDREIEEEPLSEDLE

- FOXP2 (forkhead box P2) is located on human chromosome 7q31, and its major splice form encodes a protein of 715 amino acids belonging to the forkhead class of transcription factors2.
- It contains a glutamine-rich region consisting of two adjacent polyglutamine tracts, encoded by mixtures of CAG and CAA repeats.
- Such repeats are known to have elevated mutation rates.

- When compared with a collection of 1,880 human–rodent gene pairs5, FOXP2 is among the 5% most-conserved proteins.
- The chimpanzee, gorilla and rhesus macaque FOXP2 proteins are all identical to each other and carry only one difference from the mouse and two differences from the human protein, whereas the orangutan carries two differences from the mouse and three from humans.
- Thus, although the FOXP2 protein is highly conserved, two of the three amino-acid differences between humans and mice occurred on the human lineage after the separation from the common ancestor with the chimpanzee.

- The evolutionary lineages leading to humans and mice diverged about 70 million years (Myr) ago.
- Thus, during the roughly 130 Myr of evolution that separate the common ancestor of humans and chimpanzees from the mouse, a single amino-acid change occurred in the FOXP2 protein.

- The fixation of the Fox2P genes in humans occurred during the last 200,000 years of human history, that is, concomitant with or subsequent to the emergence of anatomically modern humans.
- This is compatible with a model in which the expansion of modern humans was driven by the appearance of a more-proficient spoken language.

Humans have massivelyalterated Earth's biological and biogeochemical processes

- The evolution of "economies", "wealth" and religion
- Fear of death and derivations of new fitness models based on acquisition of resources rather than acquisition of survival skills. Wealth provides a mechanism of ensuring progeny without skills.

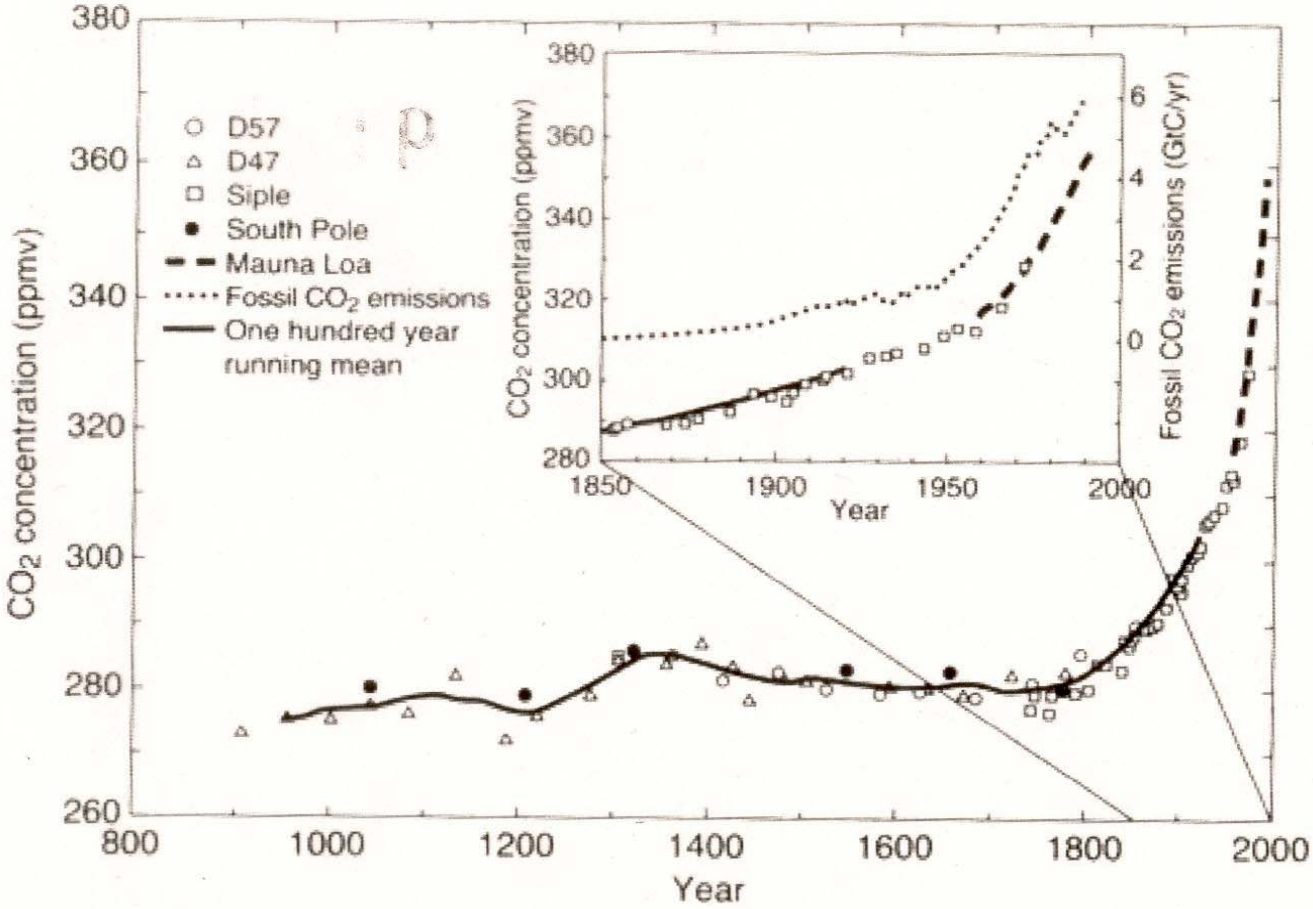


Figure 1.5: CO_2 concentrations over the past 1000 years from the recent ice core record and (since 1958) from the Mauna Loa measurement site. The inset shows the period from 1850 in more detail including CO_2 emissions from fossil fuel. Data sources: D47 and D57 (Barnola et al., in press); Siple (Neftel et al., 1985 and Friedli et al., 1986) and South Pole (Siegenthaler et al., 1988). The smooth curve is based on a 100yr running mean. All ice core measurements were taken in Antarctica.

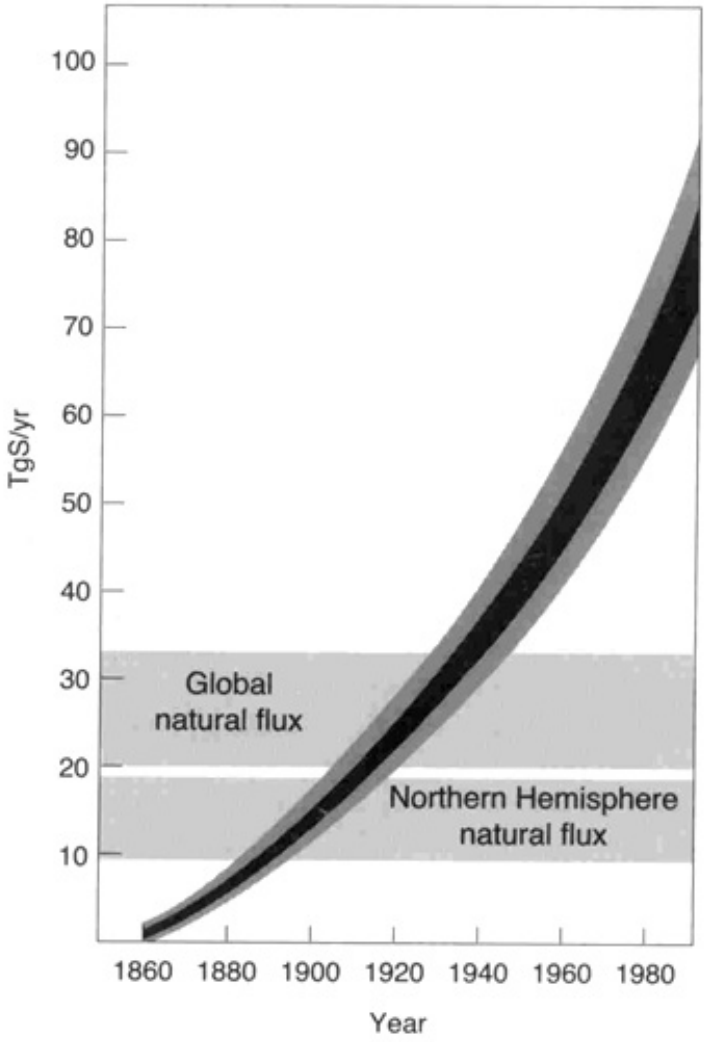
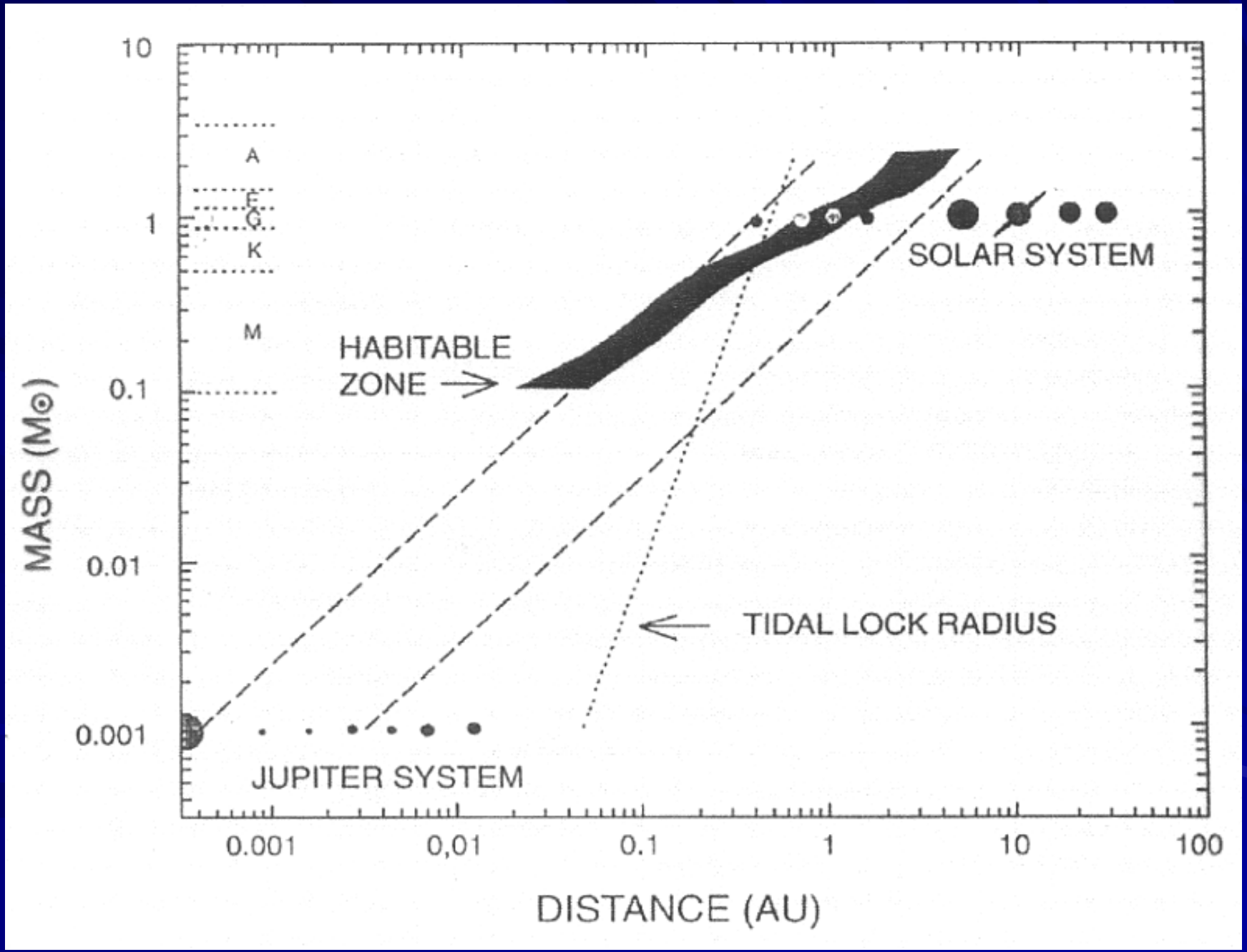


Figure 3.2: Time history of global emission of SO_2 (in TgS/yr) and estimates of the global and Northern Hemisphere natural flux (from Charlson *et al.*,1992). Anthropogenic sulphur is emitted mainly (~90%) in the Northern Hemisphere and emissions greatly exceed the natural emissions. Width of shading represents the uncertainty.

ARE WE ALONE?

- Is there evidence of life on other planets in our solar system or elsewhere in our galaxy?
- How would we know?


10
1
0.1
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HABITABLE
ZONE
SOLAR SYSTEM
TIDAL LOCK RADIUS
JUPITER SYSTEM
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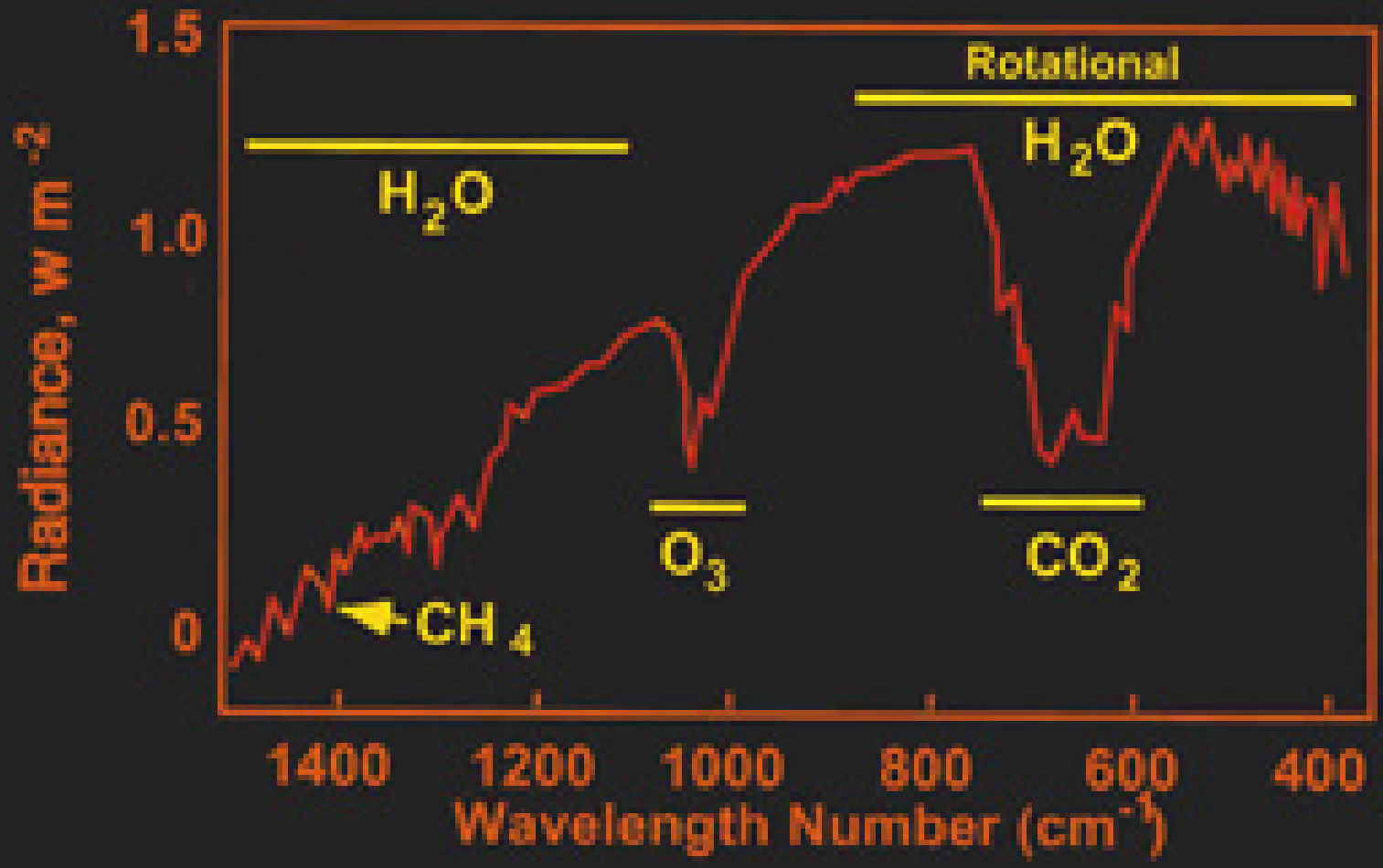
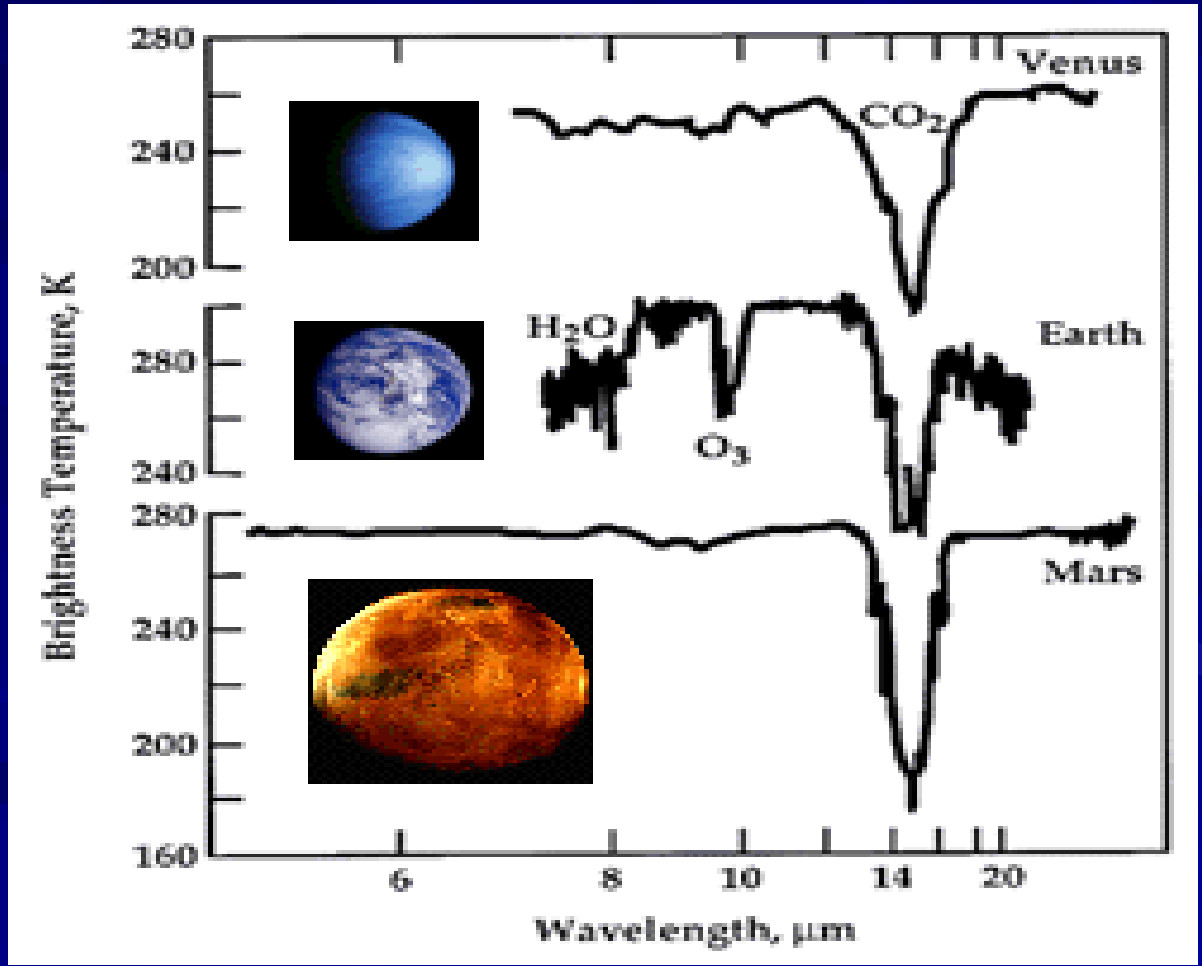
DISTANCE (AU)

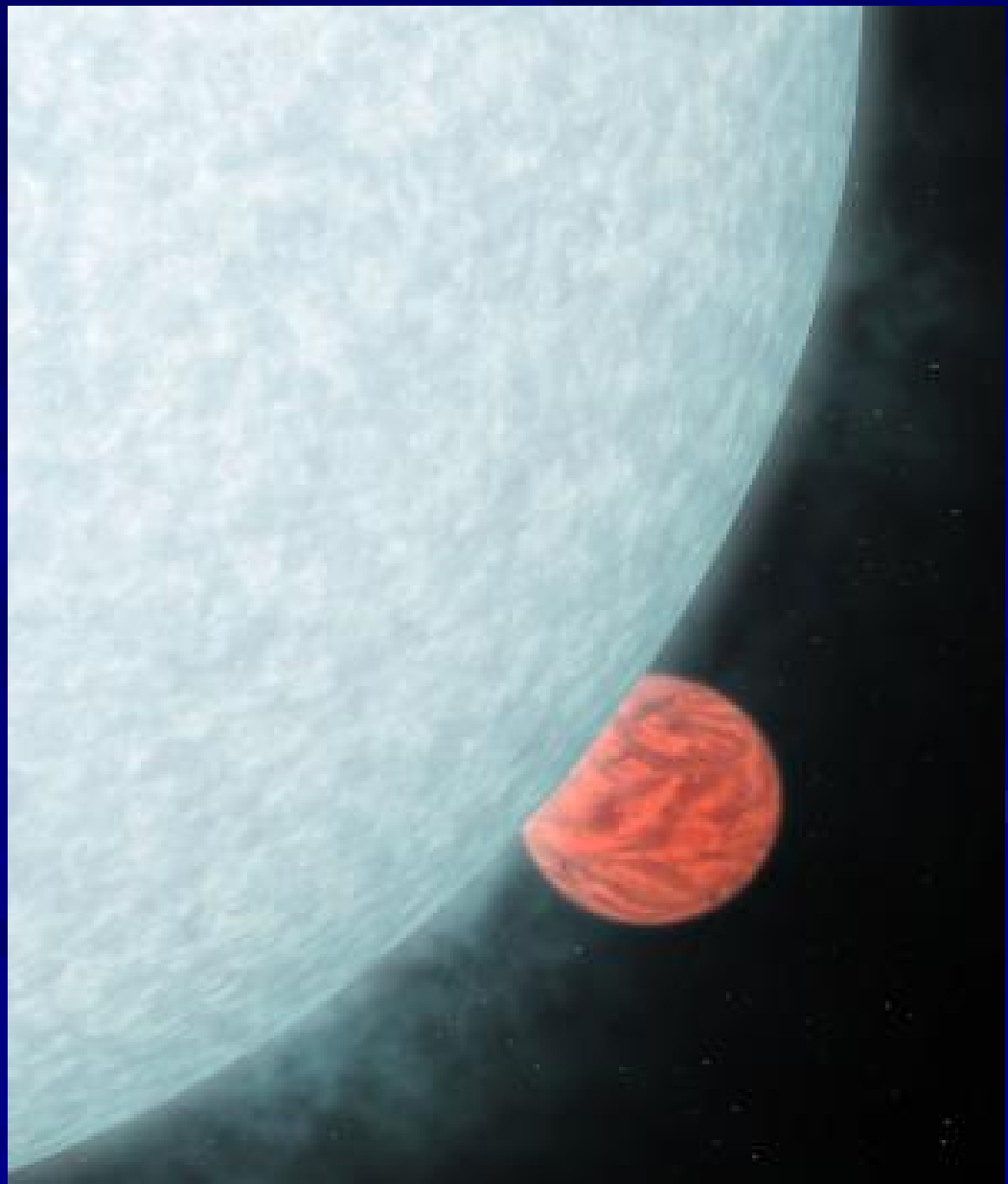
Earth's IR Reflectance Spectrum From Space



Spectra from other planets in our solar system



Glows from other planets



Terrestrial Planet Finder