Linked from "Appendix C" in *Why the Universe Is the Way It Is*

Part 2. Fine-Tuning for Intelligent Physical Life

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Evidence for the Fine-Tuning of the Galaxy-Sun-Earth-Moon System for Life Support

The environmental requirements for life to exist depend on the life form in question. The conditions for primitive life to exist, for example, are not nearly so demanding as for advanced life. A life form's activity level and longevity also make a significant difference. Given these variables, I've identified six distinct clusters of these environmental necessities, from the broadest to the narrowest:

1. for unicellular, low metabolism life that persists for only a brief time period
2. for unicellular, low metabolism life that persists for a long time period
3. for unicellular, high metabolism life that persists for a brief time period
4. for unicellular, high metabolism life that persists for a long time period
5. for advanced life that survives for just a brief time period
6. for advanced life that survives for a long time period

Complicating factors exist however. For example, unicellular, low metabolism life (extremophile life) is typically more susceptible to radiation damage and has a low molecular repair rate. Thus, the origin of life problem is far more difficult for low metabolism life (H. James Cleaves II and John H. Chambers, "Extremophiles May Be Irrelevant to the Origin of Life," *Astrobiology, 4* (2004), pp. 1-9). The following parameters of a planet, its planetary companions, its moon, its star, and its galaxy must have values falling within narrowly defined ranges for physical life of any kind to exist. References follow the list.

1. galaxy cluster type
   - if too rich: galaxy collisions and mergers would disrupt solar orbit
   - if too sparse: insufficient infusion of gas to sustain star formation for a long enough time
2. galaxy size
   - if too large: infusion of gas and stars would disturb sun's orbit and ignite too many galactic eruptions.
   - if too small: insufficient infusion of gas to sustain star formation for long enough time.
3. galaxy type
   - if too elliptical: star formation would cease before sufficient heavy element build-up for life chemistry.
   - if too irregular: radiation exposure on occasion would be too severe and heavy elements for life chemistry would not be available.
4. galaxy mass distribution
   - if too much in the central bulge: life-supportable planet will be exposed to too much radiation.

if too much in the spiral arms: life-supportable planet will be destabliized by the gravity and radiation from adjacent spiral arms.

5. galaxy location
   - if too close to a rich galaxy cluster: galaxy would be gravitationally disrupted
   - if too close to very large galaxy(ies): galaxy would be gravitationally disrupted.
   - if too far away from dwarf galaxies: insufficient infall of gas and dust to sustain ongoing star formation

6. decay rate of cold dark matter particles
   - if too small: too few dwarf spheroidal galaxies will form which prevents star formation from lasting long enough in large galaxies so that life-supportable planets become possible.
   - if too great: too many dwarf spheroidal galaxies will form which will make the orbits of solar-type stars unstable over long time periods and lead to the generation of deadly radiation episodes.

7. hypernovae eruptions
   - if too few not enough heavy element ashes present for the formation of rocky planets.
   - if too many: relative abundances of heavy elements on rocky planets would be inappropriate for life; too many collision events in planetary system
   - if too soon: leads to a galaxy evolution history that would disturb the possibility of advanced life; not enough heavy element ashes present for the formation of rocky planets.
   - if too late: leads to a galaxy evolution history that would disturb the possibility of advanced life; relative abundances of heavy elements on rocky planets would be inappropriate for life; too many collision events in planetary system

8. supernovae eruptions
   - if too close: life on the planet would be exterminated by radiation
   - if too far: not enough heavy element ashes would exist for the formation of rocky planets.
   - if too infrequent: not enough heavy element ashes present for the formation of rocky planets.
   - if too frequent: life on the planet would be exterminated.
   - if too soon: heavy element ashes would be too dispersed for the formation of rocky planets at an early enough time in cosmic history
   - if too late: life on the planet would be exterminated by radiation.

9. white dwarf binaries
   - if too few: insufficient flourine would be produced for life chemistry to proceed.
   - if too many: planetary orbits disrupted by stellar density; life on planet would be exterminated.
   - if too soon: not enough heavy elements would be made for efficient flourine production.
   - if too late: flourine would be made too late for incorporation in protoplanet.

10. proximity of solar nebula to a supernova eruption
    - if farther: insufficient heavy elements for life would be absorbed.
    - if closer: nebula would be blown apart.

11. timing of solar nebula formation relative to supernova eruption
    - if earlier: nebula would be blown apart.
    - if later: nebula would not absorb enough heavy elements.

12. number of stars in parent star birth aggregate
    - if too few: insufficient input of certain heavy elements into the solar nebula.
    - if too many: planetary orbits will be too radically disturbed.

13. star formation history in parent star vicinity
    - if too much too soon: planetary orbits will be too radically disturbed.

14. birth date of the star-planetary system
    - if too early: quantity of heavy elements will be too low for large rocky planets to form.

if too late: star would not yet have reached stable burning phase; ratio of potassium-40, uranium-235 & 238, and thorium-232 to iron will be too low for long-lived plate tectonics to be sustained on a rocky planet.

15. parent star distance from center of galaxy
    if farther: quantity of heavy elements would be insufficient to make rocky planets; wrong abundances of silicon, sulfur, and magnesium relative to iron for appropriate planet core characteristics.
    if closer: galactic radiation would be too great; stellar density would disturb planetary orbits; wrong abundances of silicon, sulfur, and magnesium relative to iron for appropriate planet core characteristics.
16. parent star distance from closest spiral arm
    if too large: exposure to harmful radiation from galactic core would be too great.
17. z-axis heights of star's orbit
    if more than one: tidal interactions would disrupt planetary orbit of life support planet
    if less than one: heat produced would be insufficient for life.
18. quantity of galactic dust
    if too small: star and planet formation rate is inadequate; star and planet formation occurs too late; too much exposure to stellar ultraviolet radiation.
    if too large: blocked view of the Galaxy and of objects beyond the Galaxy; star and planet formation occurs too soon and at too high of a rate; too many collisions and orbit perturbations in the Galaxy and in the planetary system.
19. number of stars in the planetary system
    if more than one: tidal interactions would disrupt planetary orbit of life support planet
    if less than one: heat produced would be insufficient for life.
20. parent star age
    if older: luminosity of star would change too quickly.
    if younger: luminosity of star would change too quickly.
21. parent star mass
    if greater: luminosity of star would change too quickly; star would burn too rapidly.
    if less: range of planet distances for life would be too narrow; tidal forces would disrupt the life planet's rotational period; uv radiation would be inadequate for plants to make sugars and oxygen.
22. parent star metallicity
    if too small: insufficient heavy elements for life chemistry would exist.
    if too large: radioactivity would be too intense for life; life would be poisoned by heavy element concentrations.
23. parent star color
    if redder: photosynthetic response would be insufficient.
    if bluer: photosynthetic response would be insufficient.
24. galactic tides
    if too weak: too low of a comet ejection rate from giant planet region.
    if too strong too high of a comet ejection rate from giant planet region.
25. H_3^+ production
    if too small: simple molecules essential to planet formation and life chemistry will not form.
    if too large: planets will form at wrong time and place for life.
26. flux of cosmic ray protons
    if too small: inadequate cloud formation in planet's troposphere.

if too large: too much cloud formation in planet's troposphere.

27. solar wind
    if too weak: too many cosmic ray protons reach planet's troposphere causing too much cloud formation.
    if too strong: too few cosmic ray protons reach planet's troposphere causing too little cloud formation.

28. parent star luminosity relative to speciation
    if increases too soon: runaway green house effect would develop.
    if increases too late: runaway glaciation would develop.

29. surface gravity (escape velocity)
    if stronger: planet's atmosphere would retain too much ammonia and methane.
    if weaker: planet's atmosphere would lose too much water.

30. distance from parent star
    if farther: planet would be too cool for a stable water cycle.
    if closer: planet would be too warm for a stable water cycle.

31. inclination of orbit
    if too great: temperature differences on the planet would be too extreme.

32. orbital eccentricity
    if too great: seasonal temperature differences would be too extreme.

33. axial tilt
    if greater: surface temperature differences would be too great.
    if less: surface temperature differences would be too great.

34. rate of change of axial tilt
    if greater: climatic changes would be too extreme; surface temperature differences would become too extreme.

35. rotation period
    if longer: diurnal temperature differences would be too great.
    if shorter: atmospheric wind velocities would be too great.

36. rate of change in rotation period
    if longer:surface temperature range necessary for life would not be sustained.
    if shorter:surface temperature range necessary for life would not be sustained.

37. planet age
    if too young: planet would rotate too rapidly.
    if too old: planet would rotate too slowly.

38. magnetic field
    if stronger: electromagnetic storms would be too severe; too few cosmic ray protons would reach planet's troposphere which would inhibit adequate cloud formation.
    if weaker: ozone shield would be inadequately protected from hard stellar and solar radiation; time between magnetic reversals would be too brief for the long term maintenance of advanced life civilization

39. thickness of crust
    if thicker: too much oxygen would be transferred from the atmosphere to the crust.
    if thinner: volcanic and tectonic activity would be too great.

40. albedo (ratio of reflected light to total amount falling on surface)
    if greater: runaway glaciation would develop.
    if less: runaway greenhouse effect would develop.

41. asteroidal and cometary collision rate
    if greater: too many species would become extinct.
    if less: crust would be too depleted of materials essential for life.

42. mass of body colliding with primordial Earth
    if smaller: Earth's atmosphere would be too thick; moon would be too small.
    if greater: Earth's orbit and form would be too greatly disturbed.

43. timing of body colliding with primordial Earth.
    if earlier: Earth's atmosphere would be too thick; moon would be too small.
    if later: sun would be too luminous at epoch for advanced life.

44. collision location of body colliding with primordial Earth
    if too close to grazing: insufficient debris to form large moon; inadequate annihilation of Earth's primordial atmosphere; inadequate transfer of heavy elements to Earth.
    if too close to dead center: damage from collision would be too destructive for future life to survive.

45. oxygen to nitrogen ratio in atmosphere
    if larger: advanced life functions would proceed too quickly.
    if smaller: advanced life functions would proceed too slowly.

46. carbon dioxide level in atmosphere
    if greater: runaway greenhouse effect would develop.
    if less: plants would be unable to maintain efficient photosynthesis.

47. water vapor level in atmosphere
    if greater: runaway greenhouse effect would develop.
    if less: rainfall would be too meager for advanced life on the land.

48. atmospheric electric discharge rate
    if greater: too much fire destruction would occur.
    if less: too little nitrogen would be fixed in the atmosphere.

49. ozone level in atmosphere
    if greater: surface temperatures would be too low.
    if less: surface temperatures would be too high; there would be too much uv radiation at the surface.

50. oxygen quantity in atmosphere
    if greater: plants and hydrocarbons would burn up too easily.
    if less: advanced animals would have too little to breathe.

51. 5 nitrogen quantity in atmosphere
    if greater: too much buffering of oxygen for advanced animal respiration; too much nitrogen fixation for support of diverse plant species.
    if less: too little buffering of oxygen for advanced animal respiration; too little nitrogen fixation for support of diverse plant species.

52. ratio of ^{40}K, ^{235,238}U, ^{232}Th to iron for the planet
    if too low: inadequate levels of plate tectonic and volcanic activity.
    if too high: radiation, earthquakes, and volcanoes at levels too high for advanced life.

53. rate of interior heat loss
    if too low: inadequate energy to drive the required levels of plate tectonic and volcanic activity.
    if too high: plate tectonic and volcanic activity shuts down too quickly.

54. seismic activity

if greater: too many life-forms would be destroyed; continents would grow to too large a size; vertical relief on the continents would be inadequate for the proper distribution of rainfall, snow pack, and erosion

if less: nutrients on ocean floors from river runoff would not be recycled to continents through tectonics; not enough carbon dioxide would be released from carbonates; continents would not grow to a large enough size; vertical relief on the continents would become too great

55. volcanic activity

if lower: insufficient amounts of carbon dioxide and water vapor would be returned to the atmosphere; soil mineralization would become too degraded for life.

if higher: advanced life, at least, would be destroyed.

56. rate of decline in tectonic activity

if slower: advanced life can never survive on the planet.

if faster: advanced life can never survive on the planet.

57. rate of decline in volcanic activity

if slower: advanced life can never survive on the planet.

if faster: advanced life can never survive on the planet.

58. timing of birth of continent formation

if too early: silicate-carbonate cycle would be destabilized.

if too late: silicate-carbonate cycle would be destabilized.

59. oceans-to-continents ratio

if greater: diversity and complexity of life-forms would be limited.

if smaller: diversity and complexity of life-forms would be limited.

60. rate of change in oceans-to-continents ratio

if smaller: advanced life will lack the needed land mass area.

if greater: advanced life would be destroyed by the radical changes.

61. global distribution of continents (for Earth)

if too much in the southern hemisphere: seasonal differences would be too severe for advanced life.

62. frequency and extent of ice ages

if smaller: insufficient fertile, wide, and well-watered valleys produced for diverse and advanced life forms; insufficient mineral concentrations exposed for diverse and advanced life; insufficient production of high quality harbors for advanced life

if greater: planet inevitably experiences runaway freezing.

63. soil mineralization

if too nutrient poor: diversity and complexity of life-forms would be limited.

if too nutrient rich: diversity and complexity of life-forms would be limited.

64. gravitational interaction with a moon

if greater: tidal effects on the oceans, atmosphere, and rotational period would be too severe

.if less: orbital obliquity changes would cause climatic instabilities; movement of nutrients and life from the oceans to the continents and vice versa would be insufficent; magnetic field would be too weak.

65. Jupiter distance

if greater: too many asteroid and comet collisions would occur on Earth.

if less: Earth's orbit would become unstable.; Jupiter's presence would too radically disturb or prevent the formation of Earth

66. Jupiter mass

if greater: Earth's orbit would become unstable; Jupiter's presence would too radically disturb or prevent the formation of Earth
if less: too many asteroid and comet collisions would occur on Earth.

67. drift in major planet distances
if greater: Earth's orbit would become unstable.
if less: too many asteroid and comet collisions would occur on Earth.

68. major planet eccentricities
if greater: orbit of life supportable planet would be pulled out of life support zone.

69. major planet orbital instabilities
if greater: orbit of life supportable planet would be pulled out of life support zone.

70. mass of Neptune
if too small: not enough Kuiper Belt Objects (asteroids beyond Neptune) would be scattered out of the solar system.
if too large: chaotic resonances among the gas giant planets would occur.

71. Kuiper Belt of asteroids (beyond Neptune)
if not massive enough: Neptune's orbit remains too eccentric which destabilizes the orbits of other solar system planets.
if too massive: too many chaotic resonances and collisions would occur in the solar system.

72. separation distances among inner terrestrial planets
if too small: orbits of all inner planets will become unstable in less than 100,000,000 million years.
if too large: orbits of the most distant from star inner planets will become chaotic.

73. atmospheric pressure
if too small: liquid water will evaporate too easily and condense too infrequently; weather and climate variation would be too extreme; lungs will not function.
if too large: liquid water will not evaporate easily enough for land life; insufficient sunlight reaches planetary surface; insufficient uv radiation reaches planetary surface; insufficient climate and weather variation; lungs will not function.

74. atmospheric transparency
if smaller: insufficient range of wavelengths of solar radiation reaches planetary surface
if greater: too broad a range of wavelengths of solar radiation reaches planetary surface.

75. magnitude and duration of sunspot cycle
if smaller or shorter: insufficient variation in climate and weather.
if greater or longer: variation in climate and weather would be too much.

76. continental relief
if smaller: insufficient variation in climate and weather.
if greater: variation in climate and weather would be too much.

77. chlorine quantity in atmosphere
if smaller: erosion rates, acidity of rivers, lakes, and soils, and certain metabolic rates would be insufficient for most life forms.
if greater: ersosion rates, acidity of rivers, lakes, and soils, and certain metabolic rates would be too high for most life forms.

78. iron quantity in oceans and soils
if smaller: quantity and diversity of life would be too limited for support of advanced life; if very small, no life would be possible.
if larger: iron poisoning of at least advanced life would result.

79. tropospheric ozone quantity

if smaller: insufficient cleansing of biochemical smogs would result.
if larger: respiratory failure of advanced animals, reduced crop yields, and destruction of ozone-sensitive species would result.

80. stratospheric ozone quantity
if smaller: too much uv radiation reaches planet's surface causing skin cancers and reduced plant growth.
if larger: too little uv radiation reaches planet's surface causing reduced plant growth and insufficient vitamin production for animals.

81. mesospheric ozone quantity
if smaller: circulation and chemistry of mesospheric gases so disturbed as to upset relative abundances of life essential gases in lowe atmosphere.
if greater: circulation and chemistry of mesospheric gases so disturbed as to upset relative abundances of life essential gases in lower atmosphere.

82. quantity and extent of forest fires
if smaller: growth inhibitors in the soils would accumulate; soil nitrification would be insufficient; insufficient charcoal production for adequate soil water retention and absorption of certain growth inhibitors; inadequate coverage of the planet by grasslands and savannah
if greater: too many plant and animal life forms would be destroyed; too many forests will be converted to savannah and grassland; less carbon dioxide will be removed from the atmosphere resulting in global warming; less rainfall

83. quantity and extent of grass fires
if smaller: growth inhibitors in the soils would accumulate; soil nitrification would be insufficient; insufficient charcoal production for adequate soil water retention and absorption of certain growth inhibitors.
if greater: too many plant and animal life forms would be destroyed; too many savannahs and grasslands will be converted to deserts; less rainfall

84. quantity of soil sulfer
if smaller: plants will become defieient in certain proteins and die.
if larger: plants will die from sulfur toxins; acidity of wate and soil will become too great for life; nitrogen cycles will be disturbed.

85. biomass to comet infall ratio
if smaller: greenhouse gases accumulate, triggering runaway surface temperature increase.
if larger: greenhouse gases decline, triggering a runaway freezing.

86. density of quasars
if smaller: insufficient production and ejection of cosmic dust into the intergalactic medium; ongoing star formation impeded; deadly radiation unblocked.
if larger: too much cosmic dust forms; too many stars form too late disrupting the formation of a solar-type star at the right time and under the right conditions for life.

87. density of giant galaxies in the early universe
if smaller: insufficient metals ejected into the intergalactic medium depriving future generations of stars of the metal abundances necessary for a life-support planet at the right time in cosmic history.
if larger: too large a quantity of metals ejected into the intergalactic medium providing future stars with too high of a metallicity for a life-support planet at the right time in cosmic history.

88. giant star density in galaxy

if smaller: insufficient production of galactic dust; ongoing star formation impeded; deadly radiation unblocked.
if larger: too much galactic dust forms; too many stars form too early disrupting the formation of a solar-type star at the right time and under the right conditions for life.

89. rate of sedimentary loading at crustal subduction zones:
    if smaller: too few instabilities to trigger the movement of crustal plates into the mantle thereby disrupting carbonate-silicate cycle.
    if larger: too many instabilities triggering too many crustal plates to move down into the mantle thereby disrupting carbonate-silicate cycle

90. poleward heat transport in planet's atmosphere
    if smaller: disruption of climates and ecosystems; lowered biomass and species diversity; decreased storm activity and precipitation.
    if larger: disruption of climates and ecosystems; lowered biomass and species diversity; increased storm activity.

91. polycyclic aromatic hydrocarbon abundance in solar nebula
    if smaller: insufficient early production of asteroids which would prevent a planet like Earth from receiving adequate delivery of heavy elements and carbonaceous material for life, advanced life in particular.
    if larger: early production of asteroids would be too great resulting in too many collision events striking a planet arising out of the nebula that could support life

92. phosphorus and iron absorption by banded iron formations
    if smaller: overproduction of cyanobacteria would have consumed too much carbon dioxide and released too much oxygen into Earth's atmosphere thereby overcompensating for the increase in the Sun's luminosity (too much reduction in atmospheric greenhouse efficiency).
    if larger: underproduction of cyanobacteria would have consumed too little carbon dioxide and released too little oxygen into Earth's atmosphere thereby undercomsating for the increase in the Sun's luminosity (too little reduction in atmospheric greenhouse efficiency).

93. silicate dust annealing by nebular shocks
    if too little: rocky planets with efficient plate tectonics cannot form.
    if too much: too many collisions in planetary system.; too severe orbital instabilities in planetary system.

94. size of galactic central bulge
    if smaller: inadequate production of life-essential heavy elements; inadequate infusion of gas and dust into the spiral arms preventing solar type stars from forming at the right locations late enough in the galaxy's history
    if larger: radiation from the bulge region would kill life on the life-support planet.

95. total mass of Kuiper Belt asteroids
    if smaller: Neptune's orbit would not be adequately circularized.
    if larger: too severe gravitational instabilities generated in outer solar system.

96. solar magnetic activity level
    if greater: solar luminosity fluctuations will be too large.

97. number of hypernovae
    if smaller: too little nitrogen is produced in the early universe, thus, cannot get the kinds of stars and planets later in the universe that are necessary for life.
    if larger: too much nitrogen is produced in the early universe, thus, cannot get the kinds of stars and planets later in the universe that are necessary for life.

98. timing of hypernovae production
    if too early: galaxies become too metal rich too quickly to make stars and planets suitable for life support at the right time.
    if too late: insufficient metals available to make quickly enough stars and planets suitable for life support.

99. masses of stars that become hypernovae
    if not massive enough: insufficient metals are ejected into the interstellar medium; that is, not enough metals are available for future star generations to make stars and planets suitable for the support of life.
    if too massive: all the metals produced by the hypernova eruptions collapse into the black holes resulting from the eruptions; that is, none of the metals are available for future generations of stars.

100. quantity of geobacteraceae
    if smaller or non-existent: polycyclic aromatic hydrocarbons accumulate in the surface environment thereby contaminating the environment for other life forms.

101. density of brown dwarfs
    if too low: too many low mass stars are produced which will disrupt planetary orbits
    if too high: disruption of planetary orbits

102. quantity of aerobic photoheterotrophic bacteria
    if smaller: inadequate recycling of both organic and inorganic carbon in the oceans

103. average rainfall preciptiation
    if too small: inadequate water supplies for land-based life; inadequate erosion of land masses to sustain the carbonate-silicate cycle.; inadequate erosion to sustain certain species of ocean life that are vital for the existence of all life.
    if too large: too much erosion of land masses which upsets the carbonate-silicate cycle and hastens the extinction of many species of life that are vital for the existence of all life.

104. variation and timing of average rainfall precipitation
    if too small or at the wrong time: erosion rates that upset the carbonate-silicate cycle and fail to adjust adequately the planet's atmosphere for the increase in the sun's luminosity.
    if too large or at the wrong time: erosion rates that upset the carbonate-silicate cycle and fail to adjust the planet's atmosphere for the increase in the sun's luminosity

105. average slope or relief of the continental land masses
    if too small: inadequate erosion.
    if too large: too much erosion.

106. distance from nearest black hole
    if too close: radiation will prove deadly for life

107. absorption rate of planets and planetismals by parent star
    if too low: disturbs sun's luminosity and stability of sun's long term luminosity.
    if too high: disturbs orbits of inner solar system planets; disturbs sun's luminosity and stability of sun's long term luminosity.

108. water absorption capacity of planet's lower mantle
    if too low: too much water on planet's surface; no continental land masses; too little plate tectonic activity; carbonate-silicate cycle disrupted.
    if too high: too little water on planet's surface; too little plate tectonic activity; carbonate-silicate cycle disrupted.

109. gas dispersal rate by companion stars, shock waves, and molecular cloud expansion in the Sun's birthing star cluster

if too low: too many stars form in Sun's vicinity which will disturb planetary orbits and pose a radiation problem; too much gas and dust in solar system's vicinity.
if too high: not enough gas and dust condensation for the Sun and its planets to form; insufficient gas and dust in solar system's vicinity.

110. decay rate of cold dark matter particles
if too low: insufficient production of dwarf spheroidal galaxies which will limit the maintenance of long-lived large spiral galaxies.
if too high: too many dwarf spheroidal galaxies produced which will cause spiral galaxies to be too unstable.

111. ratio of inner dark halo mass to stellar mass for galaxy
if too low: corotation distance is too close to the center of the galaxy which exposes the life-support planet to too much radiation and too many gravitational disturbances.
if too high: corotation distance is too far from the center of the galaxy where the abundance of heavy elements is too sparse to make rocky planets.

112. star rotation rate
if too slow: too weak of a magnetic field resulting in not enough protection from cosmic rays for the life-support planet.
if too fast: too much chromospheric emission causing radiation problems for the life-support planet.

113. rate of nearby gamma ray bursts
if too low: insufficient mass extinctions of life to create new habitats for more advanced species
if too high: too many mass extinctions of life for the maintenance of long-lived species

114. aerosol particle density emitted from forests
if too low: too little cloud condensation which reduces rainfall, lowers the albedo (planetary reflectivity), and disturbs climates on a global scale.
if too high: too much cloud condensation which increases rainfall, raises the albedo (planetary reflectivity), and disturbs climate on a global scale; too much smog.

115. density of interstellar and interplanetary dust particles in vicinity of life-support planet
if too low: inadequate delivery of life-essential materials
if too high: disturbs climate too radically on life-support planet

116. thickness of mid-mantle boundary
if too thin: mantle convection eddies become too strong; tectonic activity and silicate production become too great.
if too thick: mantle convection eddies become too weak; tectonic activity and silicate production become too small.

117. galaxy cluster density
if too low: insufficient infall of gas, dust, and dwarf galaxies into a large galaxy that eventually could form a life-supportable planet.
if too high: gravitational influences from nearby galaxies will disturb orbit of the star that has a life-supprtable planet thereby exposing that planet either to deadly radiation or to gravitational disturbances from other stars in that galaxy.

118. star formation rate in solar neighborhood during past 4 billion years
if too high: life on Earth will be exposed to deadly radiation or orbit of Earth will be disturbed.

119. variation in star formation rate in solar neighborhood during past 4 billion years
if too high: life on Earth will be exposed to deadly radiation or orbit of Earth will be disturbed.

120. gamma-ray burst events:

if too few: not enough production of copper, scandium, titanium, and zinc
if too many: too many mass extinction events

121. cosmic ray luminosity of Milky Way Galaxy:
if too low: not enough production of boron
if too high: life spans for advanced life too short; too much destruction of planet's ozone layer

122. air turbulence in troposphere:
if too low: inadequate formation of water droplets
if too great: rainfall distribution will be too uneven

123. primordial cosmic superwinds:
if too low of an intensity: inadequate star formation late in cosmic history
if too great of an intensity: inadequate star formation early in cosmic history

124. smoking quasars:
if too few: inadequate primordial dust production for stimulating future star formation
if too many: early star formation will be too vigorous resulting in too few stars and planets being able to form late in cosmic history

125. quantity of phytoplankton:
if too low; inadequate production of molecular oxygen and inadequate production of maritime sulfate aerosols (cloud condensation nuclei); inadequate consumption of carbon dioxide
if too great: too much cooling of sea surface waters and possibly too much reduction of ozone quantity in lower stratosphere; too much consumption of carbon dioxide

126. quantity of iodocarbon-emitting marine organisms:
if too low: inadequate marine cloud cover; inadequate water cycling
if too great: too much marine cloud cover; too much cooling of Earth's surface

127. mantle plume production:
if too low: inadequate volcanic and island production rate
if too great: too much destruction and atmospheric disturbance from volcanic eruptions

128. quantity of magnetars (proto-neutron stars with very strong magnetic fields):
if too few during galaxy's history: inadequate quantities of r-process elements are synthesized
if too many during galaxy's history: too great a quantity of r-process elements are synthesized; too great of a high-energy cosmic ray production

129. frequency of gamma ray bursts in galaxy
if too low: inadequate production of copper, titanium, and zinc; insufficient hemisphere-wide mass extinction events
if too great: too much production of copper and zinc; too many hemisphere-wide mass extinction events

130. parent star magnetic field
if too low: solar wind and solar magnetosphere will not be adequate to thwart a significant amount of cosmic rays
if too great: too high of an x-ray flux will be generated

131. amount of outward migration of Neptune
if too low: total mass of Kuiper Belt objects will be too great; Kuiper Belt will be too close to the sun; Neptune's orbit will not be circular enough and distant enough to guarantee long-term stability of inner solar system planets' orbits
if too great: Kuiper Belt will be too distant and contain too little mass to play any significant role in contributing volatiles to life-support planet or to contributing to mass extinction

events; Neptune will be too distant to play a role in contributing to the long-term stability of inner solar system planets' orbits

132. Q-value (rigidity) of Earth during its early history
 if too low: final obliquity of Earth becomes too high; rotational braking of Earth too low
 if too great: final obliquity of Earth becomes too low; rotational braking of Earth is too great

133. parent star distance from galaxy's corotation circle
 if too close: a strong mean motion resonance will destabilize the parent star's galactic orbit
 if too far: planetary system will experience too many crossings of the spiral arms

134. average quantity of gas infused into the universe's first star clusters
 if too small: wind form supergiant stars in the clusters will blow the clusters apart which in turn will prevent or seriously delay the formation of galaxies
 if too large: early star formation, black hole production, and galaxy formation will be too vigorous for spiral galaxies to persist long enough for the right kinds of stars and planets to form so that life will be possible

135. frequency of late impacts by large asteroids and comets
 if too low: too few mass extinction events; inadequate rich ore deposits of ferrous and heavy metals
 if too many: too many mass extinction events; too radical of disturbances of planet's crust

136. level of supersonic turbulence in the infant universe
 if too low: first stars will be of the wrong type and quantity to produce the necessary mix of elements, gas, and dust so that a future star and planetary system capable of supporting life will appear at the right time in cosmic history
 if too high: first stars will be of the wrong type and quantity to produce the necessary mix of elements, gas, and dust so that a future star and planetary system capable of supporting life will appear at the right time in cosmic history

137. number density of the first metal-free stars to form in the universe
 if too low: inadequate initial production of heavy elements and dust by these stars to foster the necessary future star formations that will lead to a possible life-support body
 if too many: super winds blown out by these stars will prevent or seriously delay the formation of the kinds of galaxies that could possibly produce a future life-support body

138. size of the carbon sink in the deep mantle of the planet
 if too small: carbon dioxide level in planet's atmosphere will be too high
 if too large: carbon dioxide level in planet's atmosphere will be too low; biomass will be too small

139. rate of growth of central spheroid for the galaxy
 if too small: inadequate flow of heavy elements into the spiral disk; inadequate outward drift of stars from the inner to the central portions of the spiral disk
 if too large: inadequate spiral disk of late-born stars

140. amount of gas infalling into the central core of the galaxy
 if too little: galaxy's nuclear bulge becomes too large
 if too much: galaxy's nuclear bulge fails to become large enough

141. level of cooling of gas infalling into the central core of the galaxy
 if too low: galaxy's nuclear bulge becomes too large
 if too high: galaxy's nuclear bulge fails to become large enough

142. ratio of dual water molecules, $(H_2O)_2$, to single water molecules, H_2O, in the troposphere
 if too low: inadequate raindrop formation; inadequate rainfall
 if too high: too uneven of a distribution of rainfall over planet's surface

143. heavy element abundance in the intracluster medium for the early universe
    if too low: too much star formation too early in cosmic history; no life-support body will ever form or it will form at the wrong tine and/or place
    if too high: inadequate star formation early in cosmic history; no life-support body will ever form or it will form at the wrong tine and/or place

144. quantity of volatiles on and in Earth-sized planet in the habitable zone
    if too low: inadequate ingredients for the support of life
    if too high: no possibility for a means to compensate for luminosity changes in star

145. pressure of the intra-galaxy-cluster medium
    if too low: inadequate star formation bursts in large galaxies
    if too high: star formation burst activity in large galaxies is too aggressive, too frequent, and too early in cosmic history

146. level of spiral substructure in spiral galaxy
    if too low: galaxy will not be old enough to sustain advanced life
    if too high: gravitational chaos will disturb planetary system's orbit about center of galaxy and thereby expose the planetary system to deadly radiation and/or disturbances by gas or dust clouds

147. mass of outer gas giant planet relative to inner gas giant planet
    if greater than 50 percent: resonances will generate non-coplanar planetary orbits which will destabilize orbit of life-support planet
    if less than 25 percent: mass of the inner gas giant planet necessary to adequately protect life-support planet from asteroidal and cometary collisions would be large enough to gravitationally disturb the orbit of the life-support planet

148. triggering of El Nino events by explosive volcanic eruptions
    if too seldom: uneven rainfall distribution over continental land masses
    if too frequent: uneven rainfall distribution over continental land masses; too much destruction by the volcanic events; drop in mean global surface temperature

149. time window between the peak of kerogen production and the appearance of intelligent life
    if too short: inadequate time for geological and chemical processes to transform the kerogen into enough petroleum reserves to launch and sustain advanced civilization
    if too long: too much of the petroleum reserves, both shallow subsurface and deep subsurface, will be broken down by bacterial activity into methane

150. time window between the production of cisterns in the planet's crust that can effectively collect and store petroleum and natural gas and the appearance of intelligent life
    if too short: inadequate time for collecting and storing significant amounts of petroleum and natural gas
    if too long: too many leaks form in the cisterns which lead to the dissipation of petroleum and gas

151. efficiency of flows of silicate melt, hypersaline hydrothermal fluids, and hydrothermal vapors in the upper crust
    if too low: inadequate crystallization and precipitation of concentrated metal ores that can be exploited by intelligent life to launch civilization and technology
    if too high: crustal environment becomes too unstable for the maintenance of civilization

152. quantity of dust formed in the ejecta of Population III supernovae
    if too low: number and mass range of Population II stars will not be great enough for a life-support planet to form at the right time and place in the cosmos; Population II stars will not form soon enough after the appearance of Population III stars

if too high: Population II star formation will occur too soon and be too aggressive for a life-support planet to form at the right time and place in the cosmos

153. quantity and proximity of gamma-ray burst events relative to emerging solar nebula
   if too few and too far: inadequate enrichment of solar nebula with copper, titanium, and zinc
   if too many and too close: too much enrichment of solar nebula with copper and zinc; too much destruction of solar nebula

154. heat flow through the planet's mantle from radiometric decay in planet's core
   if too low: mantle will be too viscous and, thus, mantle convection will not be vigorous enough to drive plate tectonics at the precise level to compensate for changes in star's luminosity
   if too high: mantle will not be viscous enough and, thus, mantle convection will be too vigorous resulting in too high of a level of plate tectonic activity to perfectly compensate for changes in star's luminosity

155. water absorption by planet's mantle
   if too low: mantle will be too viscous and, thus, mantle convection will not be vigorous enough to drive plate tectonics at the precise level to compensate for changes in star's luminosity
   if too high: mantle will not be viscous enough and, thus, mantle convection will be too vigorous resulting in too high of a level of plate tectonic activity to perfectly compensate for changes in star's luminosity

156. quantity of mountains on land
   if too small: not enough snow and ice to provide adequate melt water for life during the dry seasons
   if too large: too much of the planet's water would be trapped inside permanent snow and ice fields

157. average height of mountains on land
   if too low: not enough snow and ice to provide adequate melt water for life during the dry seasons
   if too high: too much of the planet's water would be trapped inside permanent snow and ice fields

158. timing of late heavy bombardment
   if too early: bombardment of Earth would be too intense; too much mass accretion; too severe a disruption of mantle and core; too much core growth
   if too late: bombardment of Earth would not be intense enough; too little oxygen would be delivered to the core; too little core growth

159. density and thickness of atmosphere
   if too low: meteoritic bombardment would cause too much damage
   if too high: dust input to the atmosphere and soil would be too low; water input would be too low

160. degree of continental land mass barrier to oceans along rotation axis
   if too low: rotation rate of planet slows down too slowly
   if too high: rotation rate of planet slows down too quickly

161. methane emissions from living plants and plant litter
   if too low: greenhouse gas input to atmosphere inadequate to prevent runaway freezing of planetary surface
   if too high: greenhouse gas input to atmosphere launches a runaway evaporation of planet's surface water

162. methane emissions from animals

if too low: greenhouse gas input to atmosphere inadequate to prevent runaway freezing of planetary surface
if too high: greenhouse gas input to atmosphere launches a runaway evaporation of planet's surface water

163. methane emissions from fossil fuel production
if too low: greenhouse gas input to atmosphere inadequate to prevent runaway freezing of planetary surface
if too high: greenhouse gas input to atmosphere launches a runaway evaporation of planet's surface water

164. lifetimes of methane in different atmospheric layers
if too short: greenhouse gas input to atmosphere inadequate to prevent runaway freezing of planetary surface
if too long: greenhouse gas input to atmosphere launches a runaway evaporation of planet's surface water

165. average mass of the first (metal-free pop III) stars to form in the universe
if too low: inadequate initial production of heavy elements and dust by these stars to foster the necessary future star formations that will lead to a possible life-support body
if too high: super winds blown out by these stars will prevent or seriously delay the formation of the kinds of galaxies that could possibly produce a future life-support body

166. rate of release of biogenic bromides into the atmosphere
if too low: tropospheric ozone and nitrogen oxides abundances in the atmosphere will be too high for healthy land life; greenhouse effect of the atmosphere may be too high to compensate for changes in solar luminosity; too much ultraviolet radiation is blocked out causing plant growth to suffer
if too high: tropospheric ozone in the atmosphere will be too low to maintain a clean enough atmosphere for healthy land life; greenhouse effect of the atmosphere may be too low to compensate for changes in solar luminosity; ozone abundance in stratosphere will become too low to block out enough uv radiation to protect surface life

167. rate of decomposition of biogenic bromides in the atmosphere
if too low: tropospheric ozone and nitrogen oxides abundances in the atmosphere will be too high for healthy land life; greenhouse effect of the atmosphere may be too high to compensate for changes in solar luminosity
if too high: tropospheric ozone in the atmosphere will be too low to maintain a clean enough atmosphere for healthy land life; greenhouse effect of the atmosphere may be too low to compensate for changes in solar luminosity; ozone abundance in stratosphere will become too low to block out enough uv radiation to protect surface life

168. solar nebula exposure to stellar winds from expanding asymptotic giant branch stars
if too low: inadequate infusion of certain alkaline-earth elements into the solar nebula
if too high: solar nebula would suffer too much reduction and/or disruption

169. height of the tallest trees
if too low: inadequate interception and capture of water from rolling fog; inadequate buildup of soil nutrients and biodeposits; loss of quality timber for sustaining human civilization
if too high: inadequate tree growth efficiency; greater level of tree damage

170. diameter of ordinary dark matter halo surrounding the galaxy
if too small: spiral structure cannot be maintained long term; galaxy will grow too rapidly; galaxy structure will become too disturbed
if too large: spiral structure cannot be maintained long term; galaxy will not grow rapidly enough; galaxy structure will become too disturbed

171. mass of ordinary dark matter halo surrounding the galaxy
 if too small: spiral structure cannot be maintained long term; galaxy will grow too rapidly; galaxy structure will become too disturbed
 if too large: spiral structure cannot be maintained long term; galaxy will not grow rapidly enough; galaxy structure will become too disturbed

172. diameter of exotic dark matter halo surrounding the galaxy
 if too small: spiral structure cannot be maintained long term; galaxy will grow too rapidly; galaxy structure will become too disturbed
 if too large: spiral structure cannot be maintained long term; galaxy will not grow rapidly enough; galaxy structure will become too disturbed

173. mass of exotic dark matter halo surrounding the galaxy
 if too small: spiral structure cannot be maintained long term; galaxy will grow too rapidly; galaxy structure will become too disturbed
 if too large: spiral structure cannot be maintained long term; galaxy will not grow rapidly enough; galaxy structure will become too disturbed

174. density of ultra-dwarf galaxies (or supermassive globular clusters) in vicinity of the galaxy
 if too low: spiral structure will not be adequately sustained; heavy element flow into galactic habitable zone will be inadequate; galactic structure stability will not be adequately maintained
 if too high: galactic core will produce too much deadly radiation; too many heavy elements will be funneled into the galactic habitable zone; galactic structure stability will not be adequately maintained

175. magnitude of air movement at the boundaries of water vapor clouds in planet's atmosphere
 if too small: inadequate electrical charges induced into cloud droplets which limits how quickly droplets merge to form raindrops large enough to fall as precipitation
 if too large: so much electrical charge would be induced into cloud droplets as to generate too frequent, too widespread, and too destructive rain and electrical storms

176. formation rate of molecular hydrogen on dust grain surfaces when the galaxy is young
 if too low: too few stars will form during the early history of the galaxy which would delay the possible formation of a planetary system capable of sustaining advanced life past the narrow epoch in the galaxy's history during which advanced life could exist
 if too high: too many stars will form during the early history of the galaxy which would lead to the shutdown of star formation and spiral structure before the epoch during which a planetary system capable of sustaining advanced life could form

177. number of medium- or large-sized galaxies merging with the galaxy since the formation and stabilization of its thick galactic disk
 if one or more: spiral structure and star formation history will be disturbed to a degree that would rule out the possibility of a planetary system capable of sustaining advanced life

178. intensity of far ultraviolet radiation from nearby stars when circumsolar disk was condensing into planets
 if too weaker: Saturn, Uranus, Neptune, and Kuiper Belt would have been much more massive, too massive for advanced life on Earth to be possible
 if too stronger: Uranus, Neptune, and the Kuiper Belt would never have formed and Saturn would have been smaller, making advanced life on Earth impossible

179. magnitude of chemical exchange occurring at the liquid core-deep mantle boundary of planet
 if too small: inadequate flow of iron-rich material to planet's surface at crustal hot spots for sustaining abundant nutrient rich flora

if too large: too much iron will be leached out of the planet's core which will lower the duration and effectiveness of planet's dynamo

180. amount of methane generated in upper mantle of planet
    if too small: inadequate delivery of methane to planet's atmosphere causing too little solar heat to be trapped by the atmosphere
    if too large: too great a delivery of methane to planet's atmosphere causing too much solar heat to be trapped by the atmosphere

181. amount of buildup of heavy elements in the galaxy
    if too small: not enough heavy elements will be incorporated into the planetary system to make advanced life possible
    if too large: too much heavy elements will be incorporated into the planetary system resulting in too many planetesimals, asteroids, and comets in the planetary system; galactic structure becomes too disturbed and/or frayed to allow for the existence of advanced life

182. timescale for the buildup of heavy elements in the galaxy
    if too short: galactic structure becomes too disturbed and/or frayed to allow for the existence of advanced life; planetary system will be endowed with too great of a quantity of radiometric elements
    if too long: planetary system will be endowed with too low of a quantity of radiometric elements; spiral structure either will collapse or too much spiral substructure will accrue

183. level of biogenic mixing of seafloor sediments
    if too low: too low of a level of marine sediment oxygen which results in a too low biomass and nutrient budget for marine coastal ecosystems

184. production of organic aerosols in the atmosphere
    if too small: depending on the particular aerosol either too little solar radiation is reflected into space or too little solar radiation is absorbed into the troposphere
    if too large: depending on the particular aerosol either too much solar radiation is reflected into space or too much solar radiation is absorbed into the troposphere

185. lifetimes of organic aerosols in the atmosphere
    if too short: depending on the particular aerosol either too little solar radiation is reflected into space or too little solar radiation is absorbed into the troposphere
    if too long: depending on the particular aerosol either too much solar radiation is reflected into space or too much solar radiation is absorbed into the troposphere

186. total mass of primordial Kuiper Belt of asteroids and comets
    if too small: inadequate outward drift of Jupiter, Saturn, Uranus, and Neptune; inadequate circularization of the orbits of Jupiter, Saturn, Uranus, and Neptune; late heavy bombardment of Earth would not be intense enough to bring about the necessary chemical transformation of Earth's crust, mantle, and core; inadequate delivery of water and other volatiles to Earth
    if too large: too much outward drift of Jupiter, Saturn, Uranus, and Neptune; late heavy bombardment of Earth would be too intense; too much delivery of water and other volatiles to Earth

187. average distance of primordial Kuiper Belt objects from the sun
    if too short: inadequate outward drift of Uranus and Neptune; inadequate circularization of Uranus and Naptune's orbits; either too much or too little outward drift of Jupiter and Saturn; timing and intensity of the late heavy bombardment could be altered so seriously as to create conditions on Earth detrimental to advanced life

if too long: inadequate outward drift of Jupiter and Saturn; inadequate circularization of Jupiter and Saturn's orbit; either no late heavy bombardment or the late heavy bombardment could be altered so seriously as to create conditions on Earth detrimental to advanced life; inadequate outward drift of Uranus and Neptune; inadequate circularization of Uranus and Neptune's orbits

188. quantity of sub-seaflour hypersaline anoxic bacteria
   if too small: inadequate sulfate reduction and methangenesis to sustain the global chemical cycles essential for sustaining advanced life and human civilization; inadequate supply of concentrated metal ores for sustaining human civilization
   if too large: too high of a level of sulfate reduction and methanogeneis to sustain the global chemical cycles essential for sustaining advanced life and human civilization

189. ratio of baryons in galaxies to baryons in between galaxies
   if too small: galaxies in the universe would be too few and too small, yielding inadequate heavy elements to make advanced life possible
   if too large: galaxies in the universe would be too large and too numerous, yielding a radiation and stellar density that would make advanced life impossible

190. ratio of baryons in galaxy clusters to baryons in between galaxy clusters
   if too small: galaxies in the universe would be too few and too small, yielding inadequate heavy elements to make advanced life possible
   if too large: galaxies in the universe would be too large and too numerous, yielding a radiation and stellar density that would make advanced life impossible

191. superwinds generated by primordial supermassive black holes
   if too few or too weak: too few baryons would be evacuated from galaxies into the intergalactic medium; galaxies in the universe would be too large and too numerous, yielding a radiation and stellar density that would make advanced life impossible
   if too many or too strong: too many baryons would be evacuated from galaxies into the intergalactic medium; galaxies in the universe would be too few and too small, yielding inadequate heavy elements to make advanced life possible

192. mass of moon orbiting life support planet
   if too small: inadequate ocean tides; planet's rotation rate will not slow down fast enough to make advanced life possible; a mass lower than about a third of the Moon's would not be adequate to stabilize the tilt of the planet's rotation axis.
   if too large: a mass higher than two percent of the Moon's would destabilize the tilt of the planet's rotation axis; ocean tides would be too great causing too much erosion and disturbing continental shelf life; planet's rotation rate would slow down so quickly as to make advanced life impossible.

193. galaxy mass
   if too small: starburst episodes occur too late in the history of the galaxy; galaxy would absorb too few dwarf and super-dwarf galaxies thereby failing to sustain star formation over a long enough period of time; structure of galaxy may become too distorted by gravitational encounters with nearby large and medium sized galaxies
   if too large: starburst episodes occur too early in the history of the galaxy; galaxy would absorb too many medium-sized, dwarf, and super-dwarf galaxies making the radiation from the galaxy's core too deadly and disturbing too radically the galaxy's spiral structure

194. density of galaxies in the local volume around life-support galaxy
   if too low: inadequate growth in the galaxy; inadequate buildup of heavy elements in the galaxy; star formation would be too anemic and history of star formation activity would be too short

if too high: galaxy would suffer catastrophic gravitational disturbances and star formation events would be too violent and too frequent; galaxy would grow too large and too quickly; astronomers' view of the universe would be significantly blocked

195. average galaxy mass in the local volume around life-support galaxy
    if too small: inadequate growth in the galaxy; inadequate buildup of heavy elements in the galaxy; star formation would be too anemic and history of star formation activity would be too short
    if too large: galaxy would suffer catastrophic gravitational disturbances and star formation events would be too violent and too frequent; galaxy would grow too large and too quickly; astronomers' view of the universe would be significantly blocked
196. rate at which the triple-alpha process (combining of three helium nuclei to make one carbon nucleus) runs inside the nuclear furnaces of stars
    if too low: stars would not manufacture enough carbon and other heavy elements to make advanced life possible before cosmic conditions would rule out the possibility of advanced life; stars may too dim
    if too high: stars would manufacture too much carbon and other heavy elements; stars may be too bright
197. surface level air pressure for life-support planet
    if too small: lung operation in animals would be too inefficient, eliminating the possibility of high respiration rate animals; wind velocities would be too high and air streams too laminar, causing devastating storms and much more uneven rainfall distribution; less lift for aircraft making air transport more dangerous and costly
    if too great: lung operation would be too inefficient, eliminating the possibility of high respiration rate animals; wind velocities would be too low, resulting in much lower rainfall on continental land masses; too much air resistance making air transport slower, more costly, and more dangerous.
198. average mass of cold dark gas-dust clouds in the galaxy
    if too small: star formation will be too anemic and stretched out over too long of a time period; spiral arm structure will be disrupted; galaxy will not generate stars of the right mean mass, mass distribution, and metallicity distribution for advanced life
    if too great: star formation will be too aggressive, occur too early, and be stretched out over too brief a time period; spiral arm structure will be disrupted; star density in neighborhood of life-support planetary system will be too high; galaxy will not generate stars of the right mean mass, mass distribution, and metallicity distribution for advanced life
199. number density of cold dark gas-dust clouds in the galaxy
    if too low: star formation will be too anemic and stretched out over too long of a time period; spiral arm structure will be disrupted
    if too high: star formation will be too aggressive, occur too early, and be stretched out over too brief a time period; spiral arm structure will be disrupted; solar neighborhood would include too many stars
200. level and frequency of ocean microseisms
    if too low: inadequate rainfall; inadequate redistribution of continental shelf nutrients
    if too high: storm intensities would become too great; rainfall levels would be too high; too much disturbance of the continental shelf environment and ecosystems
201. average slope of the coastline land masses
    if too small: inadequate input of nutrients from the continents and islands to the continental shelves; energy from wave-wave interactions and from wave-shore interactions would be too low to adequately redistribute nutrients on the continental shelves; rainfall on continents would diminish and rainfall distribution patterns would be disrupted

if too great: erosion of continents and islands would be too great; continental shelf environments and ecosystems would be too radically disturbed; storms would become too intense; too much rain would fall on the coastlines and not enough on the continent interiors.

202. depth of Earth's primordial ocean
  if too shallow: moon-forming collider would not have ejected enough of Earth's primordial ocean and atmosphere into interplanetary space; size and/or composition of the moon would be too radically disturbed
  if too deep: moon-forming collider would have ejected too much of Earth's primordial ocean and atmosphere into interplanetary space; size and/or composition of the moon would be too radically disturbed

203. rate of quartz re-precipitation on Earth
  if too low: cycling of silicon would be so disturbed as to affect the production of free oxygen by phytoplankton and the removal of carbon dioxide from the atmosphere by the weathering of silicates
  if too high: cycling of silicon would be so disturbed as to affect the production of free oxygen by phytoplankton and the removal of carbon dioxide from the atmosphere by the weathering of silicates

204. rate of release of cellular particles (fur fiber, dandruff, pollen, spores, bacteria, etc.) into the atmosphere
  if too low: inadequate production of aerosol particles that are especially effective as cloud condensation nuclei thereby resulting into too little rain, hail, snow, and fog
  if too high: too much production of aerosol particles that are especially effective as cloud condensation nuclei thereby casing too much precipitation or precipitation that is too unevenly distributed

205. rate of release of protein and viral particles into the atmosphere
  if too low: inadequate production of aerosol particles that are especially effective as cloud condensation nuclei thereby resulting into too little rain, hail, snow, and fog
  if too high: too much production of aerosol particles that are especially effective as cloud condensation nuclei thereby casing too much precipitation or precipitation that is too unevenly distributed

206. rate of leaf litter deposition upon soils
  if too low: inadequate amounts of nutrients delivered to soils; inadequate amounts of silica delivered to soils; serious disruption of silica cycling
  if too high: soils and the ecosystems within them become too deprived of light, oxygen, and carbon dioxide; interferes with nitrogen fixation;

207. availability of fossil fuels to humanity
  if less: more greenhouse gases released to the atmosphere and more air pollution as people turn to burning wood instead; more global warming, much more respiratory diseases, and more deforestation
  if much higher: fossil fuel burning would be accelerated resulting in more significant global warming and local cooling from release of particulates

208. date of star formation shutdown in the galaxy
  if too soon: no possibility of planets forming with the mix of heavy elements to support advanced life
  if too late: too high of a probability that a nearby supernova eruption or an encounter with a dense molecular cloud or a young bright star will prove deleterious to the life on the life-support planet

209. degree of central concentration of light-emitting ordinary matter for the life-support galaxy
if smaller: inadequate infusion of gas and dust into the spiral arms preventing solar type stars from forming at the right locations late enough in the galaxy's history.
if larger: radiation from the bulge region would kill life on the life-support planet.

210. degree of flatness for the light-emitting ordinary matter for the life-support galaxy
if less: spiral structure either will collapse or become unstable
if more: inadequate infusion of gas and dust into the spiral arms preventing solar type stars from forming at the right locations late enough in the galaxy's history

211. average albedo of Earth's surface life
if less: would cause runaway evaporation of Earth's frozen and liquid water
if more: would cause runaway freeze-up of Earth's water vapor and liquid water

212. infall velocity of galaxy toward center of nearest grouping of galaxies
if smaller: inadequate gas and dust would be infused into the galaxy
if larger: galaxy would suffer serious gravitational distortions

213. infall velocity of galaxy toward center of nearest supercluster of galaxies
if smaller: inadequate gas and dust would be infused into the galaxy
if larger: galaxy would suffer serious gravitational distortions

214. distance that primordial supernovae dispersed elements heavier than helium
if smaller: potential life-support planet either will possess to much or too little of the vital-poison elements
if larger: potential life support planet will lack many of the elements essential for the support of advanced life

215. collision velocity of planet colliding with primordial Earth
if too low: insufficient amount of Earth's atmosphere would be removed; too small of a moon would form
if too high: Earth would suffer too much destruction

216. photo erosion by nearby giant stars during planetary formation phase
if smaller: too low of a concentration of heavy elements in the planetary disk
if larger: too radical of a truncation of the outer part of the planetary disk and hence inadequate formation of gas giant planets that are distant from the star

217. dust extinction of that region of the spiral disk where the potential life support planet forms
if smaller: a high density rocky planet will not be able to form; potential life support planet would lack the necessary planetary companions
if larger: planetary system will be filled with too many asteroids and comets resulting in too many collision events and the delivery of too many volatiles

218. dust extinction in vicinity of life support planet at the time of the existence of advanced life
if too large: intelligent observers will experience a blocked view of the galaxy and the universe

219. surface density of the protoplanetary disk
if smaller: number of protoplanets produced would be too many; average protoplanet mass would be too small
if larger: number of protoplanets produced would be too few; average protoplanet mass would be too large

220. quantity of terrestrial lightning
if less: too small or too unstable of a charge-depleted zone would exist in the Van Allen radiation belts surrounding Earth making efficient communication satellite operation impossible; too few forest and grass fires would be generated; inadequate nitrogen fixation

if more: Earth's Van Allen belts would become so weak that too much hard radiation would penetrate to Earth's surface to the detriment of life; too many forest and grass fires would be generated

221. timing of solar system's last crossing of a spiral arm
 if earlier: humanity would now be too close to a spiral arm and thus would face more cosmic rays, a colder climate, a weaker ozone shield, and a high probability of an encounter with a large molecular clooud
 if later: humanity would now be too close to a spiral arm and thus would face more cosmic rays, a colder climate, a weaker ozone shield, and a high probability of an encounter with a large molecular cloud; inadequate time for the buildup of resources provided by previous generations of advanced life

222. amount of iron-60 injected into Earth's primordial core from a nearby type II supernova eruption
 if less: inadequate differentiation of Earth's interior layers which prevents any long-term support of plate tectonics and a strong magnetic field
 if more: Earth's plate tectonics would become too destructive; Earth's interior structure would become inappropriate for the support of life and advanced life in particular

223. density of ultra-dwarf galaxies in the vicinity of the potential life-support galaxy
 if smaller: inadequate rate of infusion of gas and dust into the potential life-support galaxy; long-term stable spiral structure cannot be sustained
 if larger: too great of an infusion of gas and dust into the potential life-support galaxy; spiral structure will be disrupted

224. quantity of molecular hydrogen formed by the supernova eruptions of population III stars (the first born stars)
 if smaller: inadequate formation of population II stars (second generation stars)
 if larger: too many population II stars would form thereby limiting the production of population I stars (third generation stars)

225. quantity of soil sulfur
 if smaller: inadequate nutrients for land life
 if larger: organic matter would be too rapidly decomposed

226. level of oxidizing activity in the soil
 if smaller: inadequate oxygenation of the soil for healthy root growth and the support of animal life in the soils; inadequate nutrients for land life
 if larger: organic matter would be too rapidly decomposed

227. level of water soluable heavy metals in soils
 if lower: inadequate trace element nutrients available for life, and especially for advanced life
 if higher: catastrophic drop in soil microorganism diversity occurs

228. quantity of methanotrophic symbionts in wetlands
 if lower: inadequate consumption and conversion of methane gas and inadequate delivery of carbon to mosses causing too much methane and carbon dioxide to be released to the atmosphere resulting in a global warming catastrophe
 if higher: too much consumption and conversion of methane gas and too much delivery of carbon to mosses causing too little methane and carbon dioxide to be released to the atmosphere resulting in a global cooling catastrophe

229. ratio of asteroids to comets for the late heavy bombardment of Earth
 if lower: inadequate delivery of heavy elements to Earth; too many volatiles would be delivered to Earth; melting of Earth would not be sufficient to adequately transform the interior of Earth

if higher: inadequate delivery of volatiles to Earth; bombardment would be too destructive; chemical transformation of Earth's interior would become inappropriate for the long-term support of advanced life

230. rate of destruction and dispersal of dust as a result of supernova eruptions in the potential life-support galaxy
if lower: density of asteroids and comets will be too high for the potential life-support planetary system resulting in too many impacts and too great a delivery of volatiles to the potential life-support planet; observers' view of the galaxy and universe will be too heavily obscured
if higher: inadequate heavy element material for the formation of a potential life support planet; inadequate delivery of volatiles and heavy elements to the potential life-support planet from comets and asteroids

231. quantity and diversity of viruses in the oceans
if lower: inadequate breakdown of particulate nutrients into usable forms for bacteria and microbial communities
if higher: too much devastation of bacteria, microorganisms, and larger life forms in the oceans

232. percent of baryons processed by the first stars (population III stars) in the vicinity of and inside the primordial Milky Way Galaxy
if lower: inadequate conversion of hydrogen and helium into heavy elements; inadequate production of molecular hydrogen; too few population II stars produced; buildup of metals will be inadequate and too slow
if higher: too much conversion of hydrogen and helium into heavy elements; too much production of molecular hydrogen; too many population II stars produced; star formation would shut down too quickly before the buildup of metals would reach the necessary levels for life

233. solar system's orbital radius about the center of the Milky Way Galaxy
if shorter than just inside the corotation radius: solar system will pass through the spiral arms too many times during the history of life
if at or very near the corotation radius: solar system will suffer a destructive mean motion resonance
if longer than the corotation radius: inadequate supply of heavy elements for the primordial solar system; solar system will pass through the spiral arms too many times during the history of life

234. quantity amommox bacteria (bacteria exploiting anaerobic ammonium oxidation reactions) in the oceans
if lower: food chain base in oxygen depleted marine environments would be driven to too low of a level
if higher: consumption of fixed nitrogen by these bacteria would deprive photosynthetic life of an important nutrient

235. quantity of soluble zinc in the oceans
if lower: too severe a limitation on the growth of nitrogen fixing marine bacteria; too severe a limitation on the growth of phytoplankton
if higher: zinc absorption by marine organisms would reach toxic levels

236. quantity of soluble silicon and silica in the oceans
if lower: too severe a limitation on the growth of marine diatoms which would remove an important food source from the food chain and an important contributor to both nitrogen fixation and marine aerosol production
if higher: silicon and silica absorption by certain marine organisms could reach toxic levels; diatom growth could become too predominant and thus damage the ecosystem

237. quantity of phosphorous and phosphates in the oceans
   if lower: too severe a limitation on the growth of nitrogen fixing marine bacteria
   if higher: growth of algae blooms could result in toxin release levels detrimental to other life forms

238. availability of light to upper layers of the oceans
   if lower: inadequate phytoplankton growth in low iron content waters
   if higher: phytoplankton growth in high iron content waters would become too aggressive and thus upset that part of marine ecosystem; certain phytoplankton blooms would release too many toxins that could prove deadly to other life forms

239. average cell size of marine phytoplankton
   if smaller: inadequate volume within the cells to support or adequately drive many important cell functions
   if larger: inadequate capacity of the cells to absorb important nutrients like iron and zinc

240. amount of summer ground foliage in the arctic
   if smaller: lower reflectivity warms the arctic possibly leading to climate instabilities
   if larger: higher reflectivity cools the arctic possibly leading to climate instabilities

241. proximity of emerging solar system nebula to red giant stars
   if closer: solar system nebula would suffer too much damage from the radiation and gravitational pull of the red giant stars
   if farther: solar system would not receive an adequate injection of flourine

242. number of red giant stars in close proximity to emerging solar system nebula
   if smaller: solar system would not receive an adequate injection of flourine
   if larger: solar system nebula would suffer too much damage from the radiation and gravitational pull of the red giant stars

243. masses of red giant stars in close proximity to emerging solar system nebula
   if smaller: solar system would not receive an adequate injection of fluorine because it would take too long for these stars to attain their epoch of maximum fluorine production and ejection
   if larger: solar system would not receive an adequate injection of fluorine because stars of such high mass produce too little flourine

244. proximity of emerging solar system nebula to fluorine-ejecting planetary nebulae
   if closer: solar system would suffer too much radiation damage
   if farther: solar system would not receive an adequate injection of flourine

245. number of fluorine-ejecting planetary nebulae in close proximity to emerging solar system nebula
   if smaller: solar system would not receive an adequate injection of flourine
   if larger: solar system would suffer too much radiation damage

246. methane production and release to the atmosphere by plants
   if less: greenhouse effect in the atmosphere becomes too inefficient causing global cooling which could lead to a runaway freezing of the planet or to climatic instabilities
   if more: greenhouse effect in the atmosphere becomes too efficient causing global warming which could lead to a runaway evaporation of the planet’s water or to climatic instabilities

247. quantity of dissolved calcium in lakes and rivers
   if smaller: inadequate removal of carbon dioxide from the atmosphere leading to climatic instabilities and possible runaway freezing
   if larger: too much removal of carbon dioxide from the atmosphere leading to climatic instabilities and possible runaway evaporation of the planet’s liquid water and ice

248. quantity of suspended calcium in lakes and rivers
    - if smaller: inadequate removal of carbon dioxide from the atmosphere leading to climatic instabilities and possible runaway freezing
    - if larger: too much removal of carbon dioxide from the atmosphere leading to climatic instabilities and possible runaway evaporation of the planet's liquid water and ice

249. frequency of core collapse supernovae
    - if smaller: inadequate production and distribution of certain heavy elements into the interstellar medium
    - if greater: too many mass extinction events on the life-support planet

250. level of rock melting during tectonic fault movements
    - if smaller: advanced life would be subject to larger and more frequent devastating earthquakes.
    - if larger: tectonic plate movement would become too rapid resulting in adequate continental stability

251. timing of continental growth spurts
    - if earlier: inadequate time for marine microorganisms to transform the chemical and physical conditions of Earth for the benefit of advanced life
    - if later: inadequate time for land life to transform the continental crust and soils for the benefit of advanced life

252. mass of the potential life support planet
    - if smaller: planet will retain too light of an atmosphere and too small of an atmospheric pressure; planet's gravity will not be adequate to retain water vapor over a long period of time; pressure in planet's mantle will be too low resulting in a loss of mantle conductivity and consequently a level of plate tectonics that is too weak
    - if greater: planet will retain too heavy of an atmosphere and too great of an atmospheric pressure; gravitational loss of low molecular weight gases from the atmosphere will be too low; tectonic activity level will be too strong and too short lived (it will die out too quickly)

253. quantity of clay production on continental land masses
    - if smaller: inadequate conditioning of soil for advanced plants; inadequate removal of carbon dioxide from the atmosphere; inadequate oxygenation of the atmosphere
    - if greater: inadequate aeration of soil for advanced plants; too much removal of carbon dioxide from the atmosphere

254. timing of advent of clay production on continental land masses
    - if earlier: reduction of Earth's atmospheric greenhouse effect overtakes the increasing luminosity of the sun; bacteria will not have had sufficient time to transform the metals and nutrients into the forms needed by clay-producing life forms
    - if later: increasing luminosity of the sun overtakes the reduction of Earth's atmospheric greenhouse effect; insufficient time for the clay-forming life forms and the ecosystems they support to build up the necessary biodeposits for humans and human civilization before the narrow time window for human civilization comes to an end

255. quantity of bacteriophages
    - if smaller: inadequate protection for advanced life against bacterial diseases
    - if greater: too much destruction of bacteria that are beneficial to advanced life

256. diversity of bacteriophages
    - if smaller: inadequate protection for advanced life against bacterial diseases
    - if greater: too much destruction of bacteria that are beneficial to advanced life

257. timing of potential life-support planet's birth relative to spiral substructure formation

if earlier: inadequate supply of life-essential heavy elements from previous generations of stars in the galaxy
if later: too much radiation and/or gravitational disturbances from the development of spiral substructure (spurs, feathers, and filaments)

258. level of warping in the Milky Way Galaxy's spiral disk
if smaller: the lack of any significant warp would imply that the MWG has had so few encounters with dwarf galaxies that it would not have received an adequate infusion of gas and dust to sustain a long enough history of star formation and the buildup of heavy elements to make advanced life possible
if greater: such warping would cause gravitational instabilities that would either pull the solar system out of its finely tuned orbit about the galactic center or expose it to deadly radiation from the galactic center or one of the adjacent spiral arms

259. date for opening of the Drake Passage (between South America and Antarctica)
if earlier: planet's surface would have been cooled down prematurely relative to the gradual increasing luminosity of the sun
if later: planet's surface would have been cooled down too late relative to the gradual increasing luminosity of the sun

260. frequency of gamma ray burst events in the galaxy
if smaller: insufficient number of the mass extinction events that pave the way for mass speciation events that perfectly compensate for the sun's increasing luminosity and build up the biodeposits required by advanced life
if greater: too many mass extinction events would disrupt the necessary history of life on Earth that is necessary to properly compensate for the increasing luminosity of the sun and to buildup the biodeposits important for the support of human civilization

261. density of the galaxy
if lower: central bulge will not be big enough; spiral arms will lack the density to funnel adequate heavy elements out to the distance where an advanced life planet would be possible
if higher: dwarf galaxy merging with the galaxy will not sustain adequate star formation for a long enough period of time

262. impact energy of moon-forming collidor event
if lower: insufficient debris generated to form the moon
if higher: resultant debris disk dissipates too rapidly thereby preventing the formation of the moon

263. density of particulates in the atmosphere
if lower: inadequate cooling of planet's surface; inadequate cooling of planet's troposphere and stratosphere; disruption of rainfall patterns
if higher: too much cooling of planet's surface; too much cooling of planet's troposphere and stratosphere; disruption of rainfall patterns

264. frequency of giant volcanic eruptions
if lower: inadequate delivery of interior gases to the atmosphere; insufficient buildup of islands and continental land masses; insufficient buildup of surface crustal nutrients
if higher: too much and too frequent destruction of life

265. degree of suppression of dwarf galaxy formation by cosmic reionization
if lower: insufficient supply of dwarf galaxies for sustaining stable spiral structure and ongoing star formation in the life support galaxy
if higher: structure of life support galaxy will be disturbed too radically by merging and collision events with dwarf galaxies

266. rate at which abiotic processes deplete nitrogen from the atmosphere by converting that nitrogen into ocean-deposited nitrates
    if lower: inadequate supply of nitrates for diverse marine life to thrive
    if higher: abundance of nitrogen in the atmosphere becomes too low to serve as an adequate buffer gas for advanced life

267. rate at which biological organisms convert nitrates in the ocean into free nitrogen that is subsequently released into the atmosphere
    if lower: abundance of nitrogen in the atmosphere becomes too low to serve as an adequate buffer gas for advanced life
    if higher: inadequate supply of nitrates for diverse marine life to thrive

268. silicon abundance in planetary system's primordial nebula
    if lower: planet formation and especially rocky planet formation will be too inefficient
    if higher: planetary system will produce an overabundance of asteroids and comets resulting in too many volatiles being delivered to the potential life support planet and too many collision events for the potential life support planet; planetary system will produce too many or too massive planets and planetesimals causing catastrophic gravitational disturbances for the potential life support planet

269. rate of decrease of the thickness of the gas disk in the life-support galaxy
    if lower: disk will not develop in a short enough time period the necessary concentration of heavy elements to make a life-support planet possible; disk will not develop the necessary density of gas and dust to adequately protect a potential life-support planet from the deadly radiation emanating from the core of the galaxy
    if higher: spiral substructure in the galaxy forms too quickly; disk becomes too thin to adequately protect a potential life-support planet from the deadly radiation emanating from the core of the galaxy

270. level of upward stirring of ocean water by krill
    if smaller: inadequate replenishment of inorganic nutrients that have been depleted by phytoplankton causing a serious drop in the productivity of phytoplankton and the regulation of atmospheric chemistry by phytoplankton; inadequate exchange of atmospheric carbon dioxide with the stratified ocean interior
    if greater: too much carbon dioxide is removed from the atmosphere; potential for problematic algae blooms; disruption of the regulation of the atmospheric chemistry by phytoplankton

271. production and release of ammonium sulfate aerosols into the atmosphere
    if lower: Earth's surface becomes warmer leading to possible climatic instabilities;
    if higher: Earth's surface becomes colder leading to possible climatic instabilities

272. timing of the great oxygenation event
    if earlier: inadequate filling of the great oxygen sinks would have occurred leading to probable large scale atmospheric oxygen abundance variations during the epoch of advanced life
    if later: atmospheric oxygen levels required by advanced life would not have been available during the time window in which advanced life could exist

273. hydrogen escape from the atmosphere to outer space
    if lower: too much methane is retained in the atmosphere resulting in a warming of the atmosphere and surface that could cause climatic instabilities and even a runaway evaporation of the planet's liquid and frozen water
    if higher: too little methane is retained in the atmosphere resulting in a cooling of the atmosphere and surface that could cause climatic instabilities and even a runaway freezing of the planet's water

274. production of H_3^+ by the galaxy's population III (first generation) stars
if lower: inadequate production of population II stars; too long of a delay in the production of population II stars
if higher: too aggressive production of population II stars; too short of a period over which population II stars are produced; subsequent star formation shuts down

275. production of H_3^+ by the galaxy's population II (second generation) stars
if lower: inadequate production of population I stars or production of population I stars is spread out over too long of a time period
if higher: production of population I stars occurs over too short of a time period

276. intensity of ultraviolet radiation arriving from the sun at the time and shortly after life's origin on Earth (before photosynthesis can establish a significant ozone shield)
if lower: synthesis of certain biochemical processes either will not proceed or will proceed too inefficiently
if higher: many biological systems and organisms would be damaged beyond repair

277. wavelength response pattern of ultraviolet radiation arriving from the sun at the time or shortly after life's origin on Earth
if longer wavelengths: synthesis of certain biochemical processes either will not proceed or will proceed too inefficiently
if shorter wavelengths: many biological systems and organisms would be damaged beyond repair

278. gas density of the local interstellar medium
if lower: inadequate suppression the heliosphere resulting in too little infall of dust from the Kuiper Belt and Oort Cloud and too little penetration of galactic cosmic rays which cause too little climatic cooling and too little ozone layer suppression respectively
if higher: too much suppression of the heliosphere resulting in more infall of dust from the Kuiper Belt and Oort Cloud and more penetration of galactic cosmic rays which cause climatic cooling and ozone layer suppression respectively

279. mass of the disk of dust, asteroids, and comets for the primordial planetary system
if smaller: late heavy bombardment will not be intense enough to adequately transform the interior of the potential life support planet; inadequate bombardment during life's history to generate the extinction events to prepare the planet for advanced life
if greater: orbits of the planets become too chaotic

280. magnitude of tidal Coulomb stresses (stress imparted by tides on tectonic fault zones)
if smaller: tectonic events will become more violent
if greater: tides will cause too much disruption and/or destruction of continental shelf habitats and continental shelf life

281. amount of methane stored in ocean clathrates
if smaller: inadequate methane would be available for certain critical chemoautotrophs
if greater: serious risk of one or more massive global warming events that could devastate advanced life

282. ratio of viscous to rotational forces in the planet's liquid core
if smaller: inadequate chemical and physical exchanges between the lower mantle and the core and between the inner and outer core
if greater: serious disruptions in the operation of the planet's dynamo would radically disturb or deteriorate the planet's magnetic field and tectonics

283. planet's oxygenation time (time for atmospheric oxygen to reach a level capable of supporting advanced life)

if longer: planet's star will no longer be stable enough to provide a steady, non-lethal illumination
if shorter: oxygenation either would continue rising reaching a level that would no longer support long-lived advanced animals and would lead to too many grass and forest fires or the oxygenation levels would vary too much for stable advanced life ecosystems

284. inward migration of icy rubble from the outer primordial planetary disk
if smaller: potential life support planet will be too dry
if greater: potential life support planet either will be too wet or too water vapor laden

285. timing of the appearance of methanogenic bacteria relative to the timing of the appearance of photosynthetic bacteria
if earlier: causes a non-linear runaway increase of the accumulation of methane in the atmosphere which would result in a greenhouse effect that would evaporate all of the planet's water
if later: inadequate input of methane in the atmosphere to build up enough of a greenhouse effect to compensate for the fainter sun at that time

286. relative abundance of methanogenic life compared to photosynthetic life
if smaller: inadequate input of methane into the atmosphere which results in too weak of a greenhouse effect thereby leading to catastrophic cooling
if greater: too much input of methane into the atmosphere which results in too strong of a greenhouse effect thereby leading to catastrophic heating

287. ratio of iron to chondritic meteorites at the time and place of Earth's birth
if smaller: Earth will not be dense enough; Earth would not sustain a long-lived strong magnetic field and plate tectonics
if greater: Earth will be too dense; Earth's crust would be too iron-rich; Earth's dynamo will not be stable enough

288. number of ultracompact dwarf galaxies in the vicinity of the potential life support galaxy during that galaxy's youth
if lower: potential life support galaxy will not grow to a large enough size; inadequate star formation during the potential life support galaxy's youth
if higher: potential life support galaxy will grow too large; structure of the potential life support galaxy will become too distorted

289. number of starless hydrogen gas clouds in the near vicinity of the potential life support galaxy
if smaller: insufficient infusion of gas into the galaxy to sustain the spiral structure and a sufficiently high level of ongoing star formation in the galaxy
if greater: too much infusion of gas into the galaxy resulting in the formation of too much spiral substructure and/or too much growth in the galaxy

290. average mass of starless hydrogen gas clouds in the near vicinity of the potential life support galaxy
if smaller: insufficient infusion of gas into the galaxy to sustain the spiral structure and a sufficiently high level of ongoing star formation in the galaxy
if greater: too much infusion of gas into the galaxy resulting in the formation of too much spiral substructure and/or too much growth in the galaxy

291. dust to gas ratio in and near the core of the potential life support galaxy during that galaxy's youth
if smaller: insufficient production of molecular hydrogen in this region leading to an inadequate star formation rate early in the galaxy's history
if greater: too much production of molecular hydrogen in this region leading to too high of a star formation rate early in the galaxy's history which in turn limits the later formation of population I type stars

292. dust temperature in and near the core of the potential life support galaxy during that galaxy's youth

if lower than 10°K: formation of molecular hydrogen is suppressed which causes star formation in this region to cease or become severely limited
if higher than 500°K: formation of molecular hydrogen is suppressed which causes star formation in this region to cease or become severely limited
if too close to the ideal temperature for formation of molecular hydrogen: too high of a star formation rate in this region early in the galaxy's history which limits the later formation of population I stars
if too far from the ideal temperature for formation of molecular hydrogen: inadequate star formation rate in this region early in the galaxy's history

293. gas temperature in and near the core of the potential life support galaxy during that galaxy's youth
if higher than a few hundred °K: formation of molecular hydrogen in this region is suppressed which causes star formation to cease or become severely limited
if too close to the ideal temperature for formation of molecular hydrogen: too high of a star formation rate in this region early in the galaxy's history which limits the later formation of population I stars
if too far from the ideal temperature for formation of molecular hydrogen: inadequate star formation rate in this region early in the galaxy's history

294. dust to gas ratio in the mid to outer parts of the potential life support galaxy during that galaxy's youth
if smaller: insufficient production of molecular hydrogen in this region leading to an inadequate star formation rate early in the galaxy's history
if greater: too much production of molecular hydrogen in this region leading to too high of a star formation rate early in the galaxy's history which in turn limits the later formation of population I type stars

295. dust temperature in the mid to outer parts of the potential life support galaxy during that galaxy's youth
if lower than 10°K: formation of molecular hydrogen in this region is suppressed which causes star formation to cease or become severely limited
if higher than 500°K: formation of molecular hydrogen in this region is suppressed which causes star formation to cease or become severely limited
if too close to the ideal temperature for formation of molecular hydrogen: too high of a star formation rate in this region early in the galaxy's history which limits the later formation of population I stars
if too far from the ideal temperature for formation of molecular hydrogen: inadequate star formation rate in this region early in the galaxy's history

296. gas temperature in the mid to outer parts of the potential life support galaxy during that galaxy's youth
if higher than a few hundred °K: formation of molecular hydrogen in this region is suppressed which causes star formation to cease or become severely limited
if too close to the ideal temperature for formation of molecular hydrogen: too high of a star formation rate in this region early in the galaxy's history which limits the later formation of population I stars
if too far from the ideal temperature for formation of molecular hydrogen: inadequate star formation rate in this region early in the galaxy's history

297. quantity of carbon monoxide in the potential life support galaxy early in its history
if lower: inadequate cooling of the molecular gas clouds causing too few stars to form at this time
if higher: too much cooling of the molecular gas clouds causing too many star to form at this time which limits how many stars can form later

298. quantity of carbon monoxide in the potential life support galaxy late in its history
    if lower: inadequate cooling of the molecular gas clouds causing too few stars to form at this time
    if higher: too much cooling of the molecular gas clouds causing too many stars to form at this time, stars whose radiation and gravity could disrupt life on a life support planet

299. number density of dark matter minihalos in the primordial Local Group
    if lower: galaxies in the Local Group will not grow fast enough and/or large enough
    if higher: galaxies in the Local Group will grow too quickly and/or grow to be too large

300. intensity or speed of high-velocity galactic outflows during the youth of the potential life support galaxy
    if lower: not enough gas and dust is ejected from the galaxy resulting in the galaxy growing to too large of a size and especially causing the galactic bulge to become too large and too massive
    if higher: causes star formation to terminate too quickly; too great a loss of heavy elements from the galaxy

301. thickness of the thick disk for the potential life support galaxy
    if thinner: spiral disk will not remain sufficiently stable, sufficiently flat, and/or sufficiently free of substructure for a long enough period of time
    if thicker: spiral disk will not be dense enough resulting in inadequate protection for the potential life support planet from deadly radiation emanating out from the galaxy's central bulge

302. rate at which the thick disk for the potential life support galaxy grows thinner
    if faster: spiral disk will not remain sufficiently stable, sufficiently flat, and/or sufficiently free of substructure for a long enough period of time
    if slower: spiral disk will not be dense enough resulting in inadequate protection for the potential life support planet from deadly radiation emanating out from the galaxy's central bulge

303. mass of the corona surrounding the potential life support galaxy
    if smaller: inadequate reservoir of baryons for sustaining ongoing star formation
    if greater: too large of reservoir of baryons for sustaining ongoing star formation resulting in a too aggressive rate of ongoing star formation

304. diameter of the corona surrounding the potential life support galaxy
    if smaller: reservoir of baryons in the corona will too efficiently sustain ongoing star formation in the galaxy resulting in a too aggressive rate of ongoing star formation
    if greater: reservoir of baryons will not sustain an efficient enough ongoing star formation rate for the galaxy

305. average strength of local gravitational instabilities in the potential life support galaxy
    if smaller: gas collapse is too slow and too inefficient resulting in too slow of a rate of star formation
    if greater: gas collapse is too quick and too efficient resulting in a too rapid rate of star formation

306. date of the last large merging event with the potential life support galaxy
    if earlier: inadequate growth in the galaxy; inadequate infusion of gas and dust into the galaxy; inadequate star formation later in the galaxy's history
    if later: morphology of the galaxy remains too disturbed at life-critical epochs in the galaxy's history; star formation history would be disrupted

307. distance of the snow line from the primordial sun at the time of planet formation

if closer: gas giant planets will form too close to the sun; inner solar system would be too volatile rich
if farther: gas giant planets will form too distant from the sun; inner solar system would be volatile poor

308. distance of the tar line from the primordial sun at the time of planet formation
if closer: Jupiter-type planet and main belt asteroids will form too close to the sun; inner solar system bodies will be gravitationally disrupted
if farther: Jupiter-type planet and main belt asteroids will form too far from the sun; Earth will not be adequately protected from comet and asteroid collisions from incoming objects from the Kuiper Belt and Oort Cloud

309. outer radius of the "dead zone," the low-viscosity, very-low-ionization zone for the primordial planetary disk
if closer: gas giant planets will form too close to the sun; inner solar system would be too gravitationally disturbed
if farther: gas giant planets will form too distant from the sun; inner solar system would not be adequately protected from comet and asteroid collisions

310. cooling efficiency of the protoplanetary disk
if smaller: either gas giant planets will not form or they will be too small , too few, or too distant from their star
if greater: gas giant planets either will be too close to their star or too numerous or too massive

311. outer protoplanetary disk lifetime
if shorter: inadequate initial inward migration of gas giant planets
if longer: too much initial inward migration of gas giant planets

312. solid to gas ration in the outer protoplanetary disk
if smaller: either gas giant planets will not form or they will be too small or too few; gas giant planet formation times will be too long
if greater: gas giant planets either will be too numerous or too massive; gas giant planet formation times will be too short

313. level of large scale turbulence in the protoplanetary disk
if smaller: inadequate transfer of refractory phases from the inner solar system to the outer solar system; inadequate transfer of carbonaceous materials from the interstellar medium and the outer solar system to the inner solar system
if greater: too much transfer of refractory material from the inner to the outer solar system; too much transfer of carbonaceous materials from the interstellar medium and the outer solar system to the inner solar system; too much chaos introduced to the protoplanetary disk

314. tidal stripping of low-mass dark matter halos during the early history of the Local Group of galaxies
if smaller: either too many dwarf galaxies would form or too many star-poor intergalactic dark matter structures would exist
if greater: either not enough dwarf galaxies would form or not enough star-poor intergalactic dark matter structures would exist

315. efficiency of gas cooling in low-mass dark matter halos during the early history of the Local Group of galaxies
if smaller: early star formation in Local Group dwarf galaxies would be too aggressive
if greater: early star formation in Local Group dwarf galaxies would not be aggressive enough

316. intensity of extragalactic ultraviolet radiation in the vicinity of low-mass dark matter halos during the early history of the Local Group of galaxies
if smaller: early star formation in Local Group dwarf galaxies would not be aggressive enough

if greater: early star formation in Local Group dwarf galaxies would be too aggressive

317. average magnetic energy density in the quiet solar photosphere
    if smaller: inadequate heating of the solar corona; inadequate solar chromospheric radiation
    if greater: too much heating of the solar corona; too much solar chromospheric radiation

318. number of tectonic plates making up the surface crust
    if fewer: too few continents and large islands; inadequate subduction; volcanism and tectonic movements either will be too little or too much
    if greater: too many continents and large islands; too much subduction; volcanism and tectonic movements either will be too little or too much

319. number density of spicules on the solar surface
    if smaller: inadequate transfer of mass into the solar corona; spectral luminosity profile of the sun would be disturbed
    if greater: too much transfer of mass into the solar corona; spectral luminosity profile of the sun would be disturbed

320. proximity of the primordial solar system nebula to the remnants of eruptions of novae
    if closer: solar system nebula would be over-enriched in silicon-carbon grains
    if farther: solar system nebula would be under-enriched in silicon-carbon grains

321. supernova rate in the life support galaxy
    if smaller: inadequate production of heavy elements
    if greater: cosmic ray intensity would be too great

322. timing of the initiation of enrichment of the interstellar medium with s-process elements for the potential life-support galaxy
    if earlier: star formation may shut down too soon; spiral structure may collapse or become too chaotic
    if later: inadequate supply of s-process elements would be available for the potential life-support planet

323. proximity of the emerging solar system nebula to either a white dwarf or a neutron star that is accreting hydrogen gas or to the stellar winds blowing out from a neutron star or a collapsar disk
    if closer: solar system nebula will be disrupted or stripped of gas
    if farther: solar system nebula will fail to be adequately enriched with p-process elements that are heavier than iron

324. density of baryons in the Local Volume of the universe
    if smaller: galaxies would be too small and numerically too sparse
    if greater: galaxies would be too big and too numerous

325. ratio of baryons in galaxies to baryons in between galaxies in the Local Volume of the universe
    if smaller: galaxies would be too small and numerically too sparse
    if greater: galaxies would be too big and too numerous

326. density of baryons in the Local Group of galaxies
    if smaller: galaxies would be too small and numerically too sparse
    if greater: galaxies would be too big and too numerous

327. ratio of baryons in galaxies to baryons in between galaxies in the Local Group of galaxies
    if smaller: galaxies would be too small and numerically too sparse
    if greater: galaxies would be too big and too numerous

328. epoch of peak star formation in the potential life support galaxy
    if earlier: not enough stars form late in the galaxy's history
    if later: too many stars form late in the galaxy's history

329. mass of the galaxy's central black hole

if smaller: central bulge of the galaxy will be too small; the central bulge will be too gas rich
if greater: central bulge of the galaxy will be too large; the central bulge will be too gas poor

330. ratio of type I to type II supernovae in the potential life support galaxy
if smaller: will not have the right mix of heavy elements for the potential life support planet
if greater: will not have the right mix of heavy elements for the potential life support planet

331. ratio of polycyclic aromatic hydrocarbons to stars in the galaxy
if smaller: planet formation in the galaxy will be suppressed; too few population I stars (late-born stars) in the galaxy
if greater: too many asteroids and comets will form; late history star formation will be too aggressive

332. number density of intracluster clouds in and around the Local Group of galaxies
if smaller: inadequate infusion of gas and dust into the Milky Way Galaxy for sustaining sufficient rate of ongoing star formation
if greater: Milky Way Galaxy and hence the solar system will be too radically disturbed

333. average mass of intracluster clouds in and around the Local Group of galaxies
if smaller: inadequate infusion of gas and dust into the Milky Way Galaxy for sustaining sufficient rate of ongoing star formation
if greater: Milky Way Galaxy and hence the solar system will be too radically disturbed

334. metallicity of the galaxy's halo
if lower; inadequate infusion of metals into the galaxy's disk
if higher: too much development of spiral substructure or too much disturbance of the main spiral structure

335. inward migration of icy meter-sized rubble from the outer part of the protoplanetary disk
if smaller: potential life support planet will become too dry
if greater: potential life support planet will become too wet

336. density of stars in the sun's birthing star cluster
if smaller: solar system will retain too many of its primordial Oort Cloud and Kuiper Belt objects which leads to greater impact rates on Earth; solar system will not capture enough bodies from protoplanetary disks surrounding nearby stars
if greater: solar system will lose too many of its primordial Oort Cloud and Kuiper Belt objects which leads to an inadequate impact rates on Earth; solar system may capture too many bodies from protoplanetary disks surrounding nearby stars

337. carbon abundance in the protoplanetary disk of the potential life support planetary system
if smaller: potential life support planet will become too carbon poor
if greater: potential life support planet will become too carbon rich

338. number density of dark matter subhalos surrounding the galaxy
if smaller: inadequate infusion of gas and dust into the galaxy
if greater: too much star formation would occur in the outer parts of the galaxy's disk

339. average mass of the dark matter subhalos surrounding the galaxy
if smaller: inadequate infusion of gas and dust into the galaxy
if greater: too much star formation would occur in the outer parts of the galaxy's disk

340. formation times for the dark matter halo and subhales surrounding the galaxy
if earlier: too many satellite galaxies and satellite gas clouds will form
if later: too few satellite galaxies and satellite gas clouds will form

341. ratio of average surface magnetic field strength to the expansion factor of open magnetic flux tubes on the sun

if smaller: solar wind speed will be too low; not enough suppression of Earth's ionosphere or of ozone in the stratosphere
if greater: solar wind speed will be too high resulting in too many and too intense geomagnetic storms; too much suppression of Earth's ionosphere, and too much destruction of ozone in the stratosphere

342. rate of growth of the galactic bulge in the spiral galaxy
if slower: buildup of heavy element abundance would take place too slowly; galaxy will be too metal poor
if faster: buildup of heavy element abundance would occur too quickly; galaxy will be too metal rich; galaxy's physical structure would probably become too disturbed

343. strength of the ultraviolet background for the protogalaxy
if weaker: protogalaxy will collapse too efficiently and too quickly; spiral structure will not form or too much star formation will occur early in the galaxy's history
if stronger: protogalaxy either will not collapse or it will collapse too slowly and too inefficiently; spiral structure will not form or too few stars will form early in the galaxy's history

344. proximity of the emerging solar system nebula to very low mass red giant and asymptotic giant branch stars
if closer: emerging solar system nebula will be exposed to too much radiation and may suffer too much gravitational disturbance
if farther: emerging solar system nebula will not be adequately enriched with large-grained graphite, silicon carbide, corundum, and spinel

345. richness or density of galaxies in the supercluster of galaxies
if smaller: inadequate supply of dwarf galaxies for sustaining the spiral structure and the star formation history for the potential life support galaxy
if greater: density of galaxies would be so great as to disturb the structure and the star formation history of the potential life support galaxy

346. misalignment angle between the magnetic and rotational axes of the star during the planet formation era
if smaller: inadequate inward migration of the planets from their birthing sites in the protoplanetary disk
if greater: too much inward migration of the planets from their birthing sites in the protoplanetary disk

347. infall velocity of matter into the dark matter halo of the potential life support galaxy
if smaller: inadequate accretion of matter; inadequate accretion of satellite dark matter halos; dark matter halo remains too samll
if greater: too much accretion of matter; too much accretion of satellite dark matter halos; dark matter halo becomes too large

348. quantity of hydroxyl (OH) in the planet's troposphere
if smaller: too much methane and carbon monoxide would accumulate in the planet's atmosphere resulting in a powerful greenhouse effect and respiratory problems for advanced life; too little ozone would be produced in the troposphere
if greater: not enough methane would accumulate in the planet's atmosphere; too much ozone would be produced in the troposphere

349. quantity of hydroxyl (OH) in the planet's stratosphere
if smaller: too much methane and carbon monoxide would accumulate in the planet's atmosphere resulting in a powerful greenhouse effect and respiratory problems for advanced life; too little ozone would be produced in the stratosphere

if greater: not enough methane would accumulate in the planet's atmosphere; too much ozone would be produced in the stratosphere

350. level of magnetization of the spiral disk for the potential life support galaxy
    if smaller: spiral structure will lack long term stability
    if greater: too much spiral substructure (spurs and feathers) will develop

351. metallicity of the galaxy's halo
    if smaller: inadequate infusion of heavy elements into the habitable zone of the galaxy
    if greater: too much disturbance of the spiral structure of the galaxy or too much growth in the galaxy's main structure and/or substructure

352. strength of the wind emanating from the galaxy's nuclear core
    if smaller: galactic bulge will grow too large; inadequate heavy element enrichment of the galaxy's habitable zone
    if greater: galactic bulge will remain too small; too great a buildup of spiral substructure; too much disturbance of the galaxy's habitable zone

353. mass of the initial or primordial galaxy
    if smaller: rate if merger events with other galaxies will be too low
    if greater: rate of merger events with other galaxies will be too high

354. mass of the galaxy's central black hole
    if smaller: outflow from the vicinity of the black hole will not adequately suppress star formation in the galaxy
    if greater: outflow from the vicinity of the black hole will too aggressively suppress star formation in the galaxy

355. date for the formation of the galaxy's central black hole
    if earlier: outflows from the vicinity of the black hole may too quickly or too aggressively suppress star formation in the galaxy
    if greater: outflows from the vicinity of the black hole may not adequately suppress star formation early enough or aggressively enough

356. level of mixing of the elements and chemicals in the protoplanetary disk
    if smaller: Earth will not have an adequate abundance of the lighter elements and compounds
    if greater: Earth will not possess an adequate abundance of the heaviest elements and compounds

357. level of enhanced mixing in the interiors of low-mass red giant stars that were in the vicinity of the solar system's protoplanetary disk
    if smaller: inadequate infusion of flouring into the solar system's protoplanetary disk
    if greater: too much infusion of fluorine into the solar system's protosplanetary disk

358. date when half the stars in the galaxy would have already been formed
    if earlier inadequate buildup of heavy elements
    if later: too much disruption of the galaxy's structure and radiation late in its history

359. density of dwarf dark matter halos in the vicinity of the Milky Way Galaxy
    if smaller: number of small-scale merger events will be too low to maintain the Galaxy's spiral structure and ongoing star formation history
    if greater: number of small-scale merger events will be too high resulting in too much growth and too much disturbance of the Galaxy

360. metallicity enrichment by dwarf galaxies of the intergalactic medium in the vicinity of the potential life support galaxy
    if smaller: inadequate metal enrichment of the galaxy
    if greater: too much metal enrichment of the galaxy

361. average star formation rate throughout cosmic history for dwarf galaxies that are in the vicinity of the potential life support galaxy
    - if smaller: too much infusion of gas into the potential life support galaxy which results in too aggressive episodes of star formation in that galaxy during the potential life support epoch
    - if greater: inadequate infusion of gas into the potential life support galaxy which results in too anemic episodes of star formation in that galaxy leading up to the potential life support epoch

362. quantity of heavy elements infused into the intergalactic medium by dwarf galaxies in the vicinity of the potential life support galaxy during the first two billion years of cosmic history
    - if smaller: inadequate metal enrichment of the galaxy
    - if greater: too much metal enrichment of the galaxy

363. quantity of heavy elements infused into the intergalactic medium by the superwinds of large galaxies in the vicinity of the potential life support galaxy during the first two billion years of cosmic history
    - if smaller: inadequate metal enrichment of the galaxy
    - if greater: too much metal enrichment of the galaxy

364. quantity of diffuse, large-grained intergalactic dust in the vicinity of the potential life support galaxy
    - if smaller: inadequate enrichment of certain heavy elements into the galaxy during its late history
    - if greater: too much enrichment of certain heavy elements into the galaxy during its late history

365. ratio of baryonic matter to exotic matter in dwarf galaxies in the vicinity of the potential life support galaxy
    - if smaller: dwarf galaxies will not be stable enough and hence will be subject to early dissipation and/or destruction
    - if greater: dwarf galaxies will cause too great of a gravitational disturbance when they are absorbed by the potential life support galaxy

366. ratio of baryons in the intergalactic medium relative to baryons in the circumgalactic medium for the potential life support galaxy
    - if smaller: galaxy will receive too many merger events with other galaxies
    - if greater: galaxy's structure will not be stable for a long enough period of time

367. intergalactic photon density in the vicinity of the potential life support galaxy
    - if smaller: optical depth of intergalactic space in the vicinity of the galaxy will be too low resulting in too much deadly radiation from gamma ray burst events and other high-energy phenomena in the universe
    - if greater: optical depth of intergalactic space in the vicinity of the galaxy will be too high resulting in an inadequate production of certain heavy elements and inadequate seeding of the life support planet's atmosphere

368. frequency of mega-volcanic eruptions on the life support planet
    - if lower: inadequate replenishment of soil fertility; inadequate number of mass extinction events
    - if higher: too much disturbance of the global climate; too many mass extinction events

369. timing of the introduction of the equivalent of a human species relative to the last mega-volcanic eruption
    - if too soon: global climate and the ozone shield will not have had adequate time to recover
    - if too late: too high of a risk of a subsequent mega-volcanic eruption; inadequate soil enrichment

370. percentage of the planet's surface covered by forests

if smaller: inadequate absorption of carbon dioxide from the atmosphere resulting in too much global warming; altered albedo of the planet disturbs global climate; inadequate release of aerosols to the atmosphere lowers global rainfall; inadequate habitat space for certain plant and animal species

if greater: too much absorption of carbon dioxide from the atmosphere resulting in too much global cooling; altered albedo of the planet disturbs global climate; too much release of aerosols to the atmosphere increases global rainfall; inadequate habitat space for certain species of plants and animals

371. high latitude precipitation
    if lower: inadequate moisture for abundant high latitude biota
    if higher: too much high latitude glaciation

372. duration of El Nino events
    if shorter: rainfall distribution becomes too uneven
    if longer: rainfall distribution becomes too uneven; too much global warming

373. quantity and diversity of plant parasites
    if lower: inadequate nutrient cycling in the soils; reduced plant diversity
    if higher: too much devastation of plants

374. quantity and diversity of fungi on the continental land masses
    if lower: inadequate production of clays and clay sediments leading to an inadequate rate of burial of organic carbon which in turn results in too little and too late oxygenation of the planet's atmosphere
    if higher: too much devastation of plants and animals

375. quantity of volatile organic compounds released into the atmosphere by trees
    if lower: inadequate removal of ground level and tropospheric ozone; inadequate removal of hydroxyl radicals from the troposphere; inadequate production of organic haze; inadequate production of organic aerosols
    if higher: too much removal of ground level and tropospheric ozone; too much removal of hydroxyl radicals from the troposphere; too much production of organic haze; too much production of organic aerosols

376. average pore pressure at subduction zones
    if lower: inadequate lubrication of subduction zones leads to many destructive earthquakes
    if higher: too much slippage will occur at subduction zones causing continental plate movements to become too rapid

377. average rate of migration of aqueous fluids through the planet's upper crust
    if lower: inadequate heavy-metal ore deposits will be generated
    if higher: planet's upper crust becomes too unstable

378. trace element abundance in atmospheric dust
    if lower: inadequate delivery of critical nutrients to surface marine life which limits both the rate of calcification by marine life and the sequestration of carbon into the deep ocean which in turn affects the global climate
    if higher: delivery of critical nutrients to surface marine life leads to large algal blooms which can poison certain life forms and which increases the rate of calcification by marine life and the sequestration of carbon into the deep ocean which in turn affects the global climate

379. level of dust supply to the surfaces of oceans
    if lower: inadequate delivery of critical nutrients to surface marine life which limits both the rate of calcification by marine life and the sequestration of carbon into the deep ocean which in turn affects the global climate

if higher: delivery of critical nutrients to surface marine life leads to large algal blooms which can poison certain life forms and which increases the rate of calcification by marine life and the sequestration of carbon into the deep ocean which in turn affects the global climate

380. soil moisture level
if lower: inadequate precipitation upon continental land masses
if higher: too much precipitation upon continental land masses

381. level of deep ocean convection
if lower: inadequate oxygenation of the deep ocean; deep sea life suffers
if higher: inadequate oxygen supplies for life just below the ocean surface

382. rate of remineralization of particulate organic matter
if lower: export of carbon from the surface ocean to the deep ocean and the ocean floor is much reduced resulting in a buildup of carbon dioxide in the atmosphere and subsequent global warming and a possible runaway evaporation of water
if higher: export of carbon from the surface ocean to the deep ocean and the ocean floor is much enhanced resulting in a reduction of carbon dioxide in the atmosphere and subsequent global cooling and a possible runaway freezeup

383. quantity of large-celled sulfur bacteria in the oceans
if lower: inadequate deposition of phosphates and phosphorite on the sea floor thereby removing a major source of future phosphorus nutrients for land life and a major source of phosphate and phosphorite deposits for human exploitation
if higher: inadequate phosphorus will be available to sustain a large biomass of surface marine life

384. quantity of sulfuric acid in the troposphere
if lower: inadequate formation of cloud condensation nuclei causing less rain to fall and a significant change in the planet's albedo
if higher: acid rain negatively impacts the biosphere

385. quantity of ammonia in the troposphere
if lower: inadequate formation of cloud condensation nuclei causing less rain to fall and a significant change in the planet's albedo
if higher: advanced life forms will experience respiratory problems; acid rain negatively impacts the biosphere

386. quantity of iodine oxide in the troposphere
if lower: inadequate formation of cloud condensation nuclei causing less rain to fall and a significant change in the planet's albedo
if higher: certain life forms may esperie4nce toxic levels of iodine while others may suffer from a lack of iodine

387. level of atmospheric oxidation of aromatics
if lower: inadequate formation of cloud condensation nuclei causing less rain to fall and a significant change in the planet's albedo
if higher: advanced life forms will experience respiratory impairment or respiratory failure

388. quantity of fallen leaf litter
if lower: inadequate amounts of silica are returned to the soil
if higher: inadequate oxygenation of the soil; damage from fires consuming leaf litter can become too destructive; growth inhibitors in the soil would accumulate

389. quantity and extent of wetland ecosystems
if lower: inadequate burial of organic carbon resulting in too much carbon dioxide in the atmosphere; inadequate habitat and feeding space for a wide variety of bird species

if higher: too much burial of organic carbon resulting in too little carbon dioxide in the atmosphere

390. quantity of endophytic methanotrophic bacteria in freshwater wetland ecosystems
    if lower: too much methane will be released to the atmosphere resulting in global warming; inadequate supply of carbon to wetland plants; inadequate denitrification of nitrate
    if higher: not enough methane will be released to the atmosphere resulting in global cooling

391. quantity of marine methanotrophic archaea
    if lower: too much methane will be released to the atmosphere resulting in global warming; inadequate supply of carbon to wetland plants
    if higher: not enough methane will be released to the atmosphere resulting in global cooling

392. quantity and diversity of viruses in the oceans
    if lower: inadequate control of planktonic species; inadequate control of algal blooms; impairment of nutrient cycling
    if higher: mortality rate for ocean life becomes too high; impairment of nutrient cycling

393. quantity of termites
    if lower: inadequate release of methane into the atmosphere resulting in global cooling; inadequate recycling of timber and other celluloid products
    if higher: too great a release of methane into the atmosphere resulting in global warming; too much destruction of wooden structures

394. quantity and diversity of siderophore-secreting bacteria in the oceans
    if lower: inadequate acquisition of iron by marine life
    if higher: too great iron acquisition can lead to the development of deadly algal blooms

395. quantity of carbon dioxide extracted from the mantle by melting beneath mid-ocean ridges
    if lower: inadequate rate of release of carbon dioxide into the atmosphere
    if higher: too great a rate of release of carbon dioxide into the atmosphere

396. quantity of carbon dioxide extracted from the mantle by volcanic eruptions
    if lower: inadequate rate of release of carbon dioxide into the atmosphere
    if higher: too great a rate of release of carbon dioxide into the atmosphere

397. quantity of soil nitrogen
    if lower: plant growth is limited especially the capacity of plants to remove carbon dioxide from the atmosphere which results in global warming
    if higher: nitrogen compounds could reach toxic levels or the growth of plants could be so stimulated that too much carbon dioxide is removed from the atmosphere resulting in global cooling

398. quantity of marine snow (dead cells, shreds of plankton, bits of faeces, and mineral grains) in the oceans
    if lower: inadequate release of organic carbon into the deep ocean and ocean bottom for the life forms that reside there; inadequate removal of carbon dioxide from the atmosphere
    if higher: too much removal of carbon dioxide from the atmosphere

399. radiative thermal conductivity of the lower mantle
    if lower: convection in the mantle will be too vigorous which will make the tectonic plates too unstable and result in too much plate tectonic activity
    if higher: convection in the mantle will be too tepid which will result in too weak of a level of plate tectonic activity

400. average size of aerosol particles in the troposphere
    if smaller: cloud drop nucleating activity will be too low causing less rain to fall

if larger: cloud nucleating activity will be too high either causing too much rain to fall or causing rainfall to be much less evenly distributed over the planet's surface

401. rate of atmospheric dust deposition into the oceans
if lower: inadequate infusion of nutrients (iron, phosphorus, nitrogen, etc.) essential for the growth and productivity of plankton
if higher: erosive effects on the continental land masses will disturb and/or destroy many land life forms; productivity and diversity of land life will suffer

402. level of mixing in the early protoplanetary disk of the solar nebula
if lower: proto-Earth would not receive a great enough diversity of elements and compounds
if higher: the development of small bodies in the disk would be too limited; the proto-Earth would be enriched sufficiently in very heavy elements

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