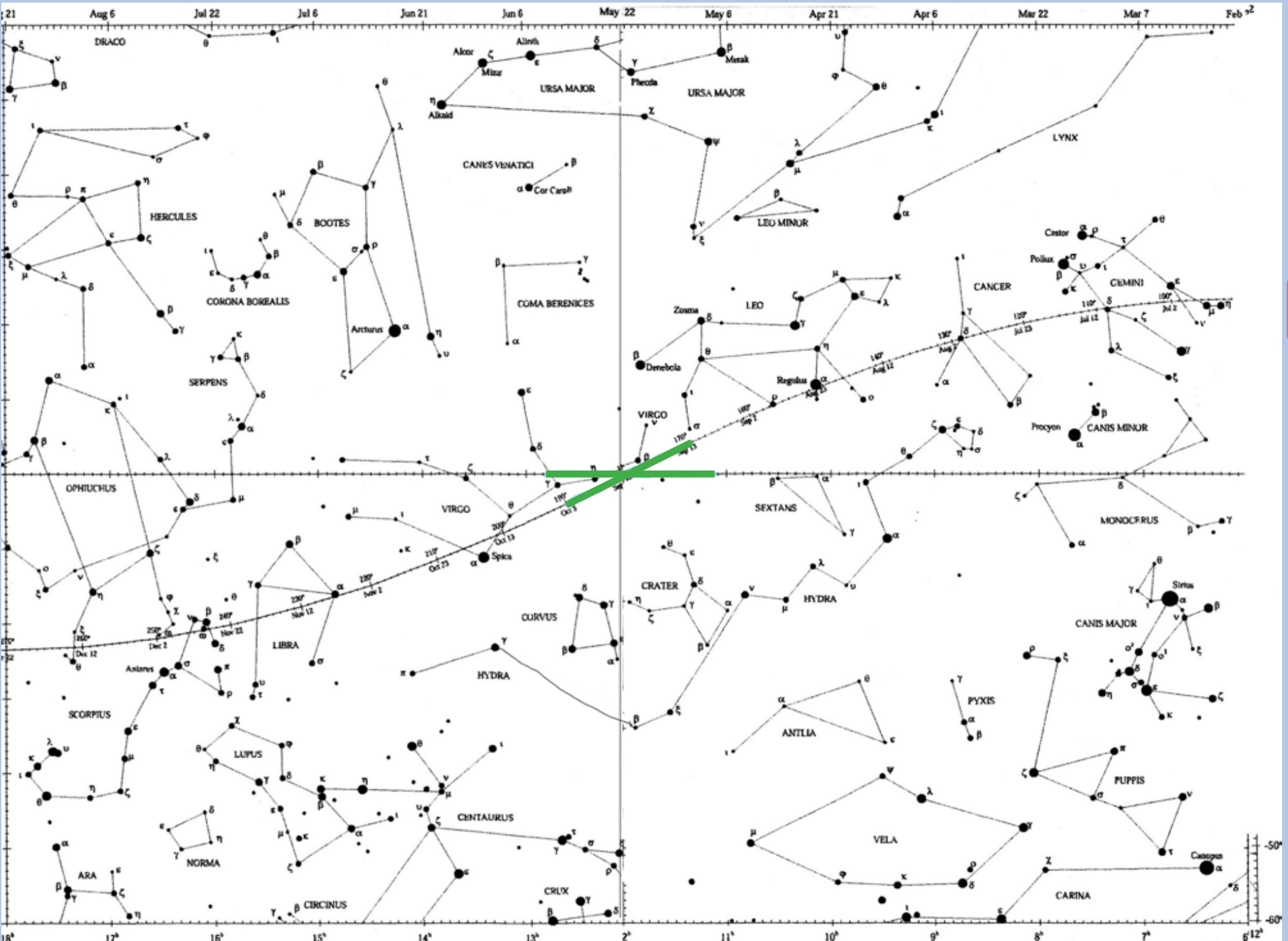
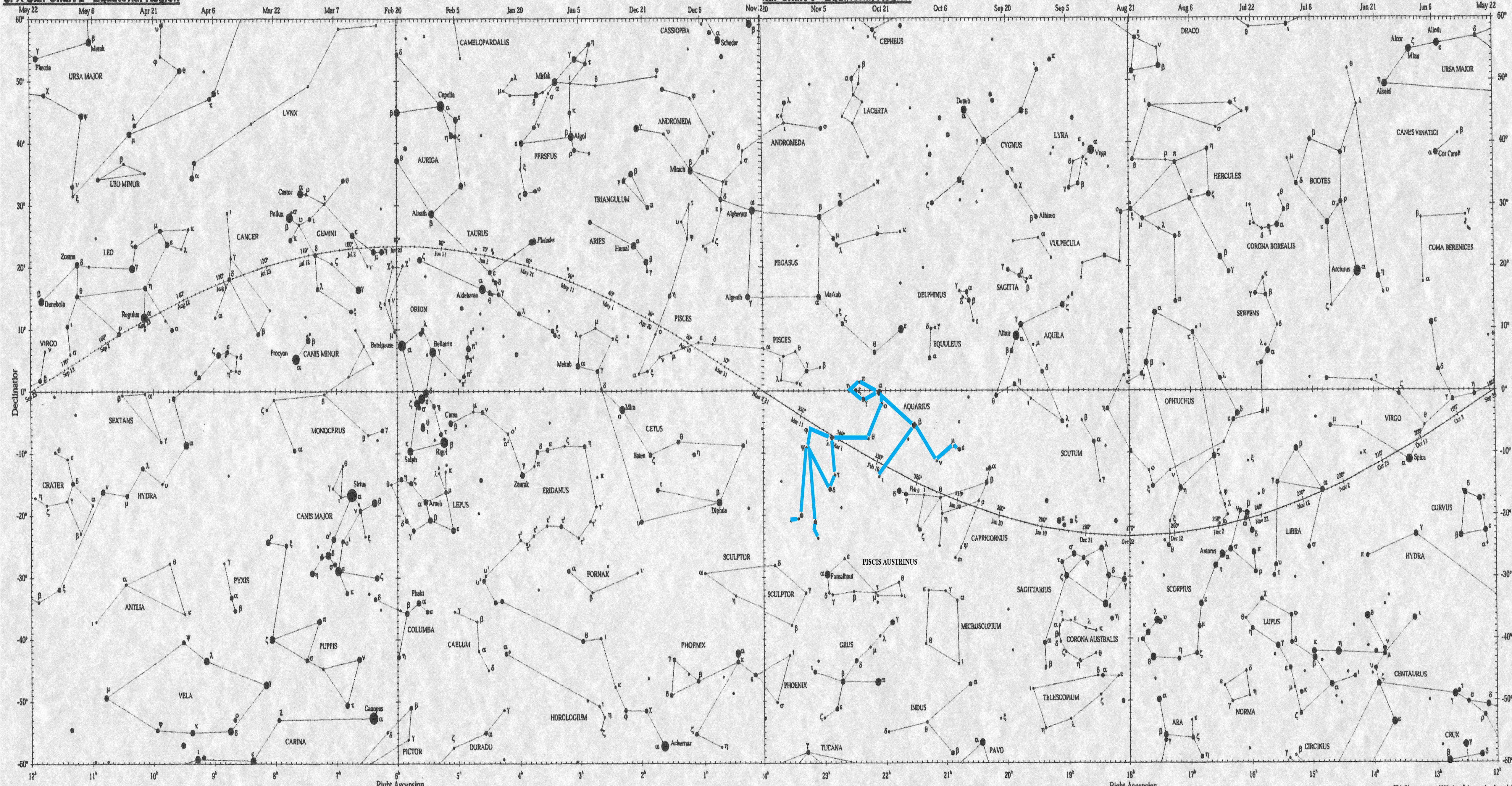


FALL EQUINOX

SFA Star Chart 2 - Equatorial Region

Star Chart 3 - Equatorial Region

Local Meridian for 8 PM


May 22
May 6
Apr 21
Apr 6
Mar 22
Mar 7
Feb 20
Feb 5
Jan 20
Jan 5
Dec 21
Dec 6
Nov 20
Nov 5
Oct 21
Oct 6
Sep 20
Sep 5
Aug 21
Aug 6
Jul 22
Jul 6
Jun 21
Jun 6
May 22
Declination
Right Ascension
URSA MAJOR
LYNX
LEO MINOR
CANCER
GEMINI
LEO
VIRGO
CANIS MINOR
SEXTANS
MONOCEROS
CRATER
HYDRA
CANIS MAJOR
ANTLIA
PYXIS
PUPPIS
VELA
CARINA
CAMELOPARDALIS
AURIGA
PERSEUS
CASSIOPEIA
ANDROMEDA
TRIANGULUM
ARIES
TAURUS
ORION
PISCES
CETUS
ERIDANUS
LEPUS
FORNAX
SCULPTOR
COLUMBA
CAELUM
HOROLOGIUM
PHOENIX
PICTOR
DORADO
CEPHEUS
LACERTA
PEGASUS
CYGNUS
LYRA
VULPECULA
DELPHINUS
SAGITTA
EQUULEUS
AQUILA
AQUARIUS
SCUTUM
CAPRICORNUS
PISCIS AUSTRINUS
MICROSCOPIUM
SAGITTARIUS
CORONA AUSTRALIS
GRUS
INDUS
TELESCOPIUM
TUCANA
PAVO
DRACO
HERCULES
CANES VENATICI
BOOTES
CORONA BOREALIS
COMA BERENICES
SERPENS
OPHIUCHUS
LIBRA
SCORPIUS
LUPUS
CORVUS
CENTAURUS
NORMA
ARA
CIRCINUS
CRUX
Merak
Phecda
Castor
Pollux
Zosma
Denebola
Regulus
Procyon
Betelgeuse
Bellatrix
Rigel
Saiph
Sirius
Canopus
Capella
Alnath
Aldebaran
Pleiades
Mirfak
Algol
Schedar
Mirach
Alpheratz
Algenib
Hamal
Menkar
Mira
Baten
Diphda
Achernar
Zaurak
Arneb
Phakt
Deneb
Vega
Albireo
Altair
Markab
Fomalhaut
Alcor
Mizar
Alioth
Alkaid
Cor Caroli
Arcturus
Spica
Antares
12h
11h
10h
9h
8h
7h
6h
5h
4h
3h
2h
1h
0h
23h
22h
21h
20h
19h
18h
17h
16h
15h
14h
13h
12h

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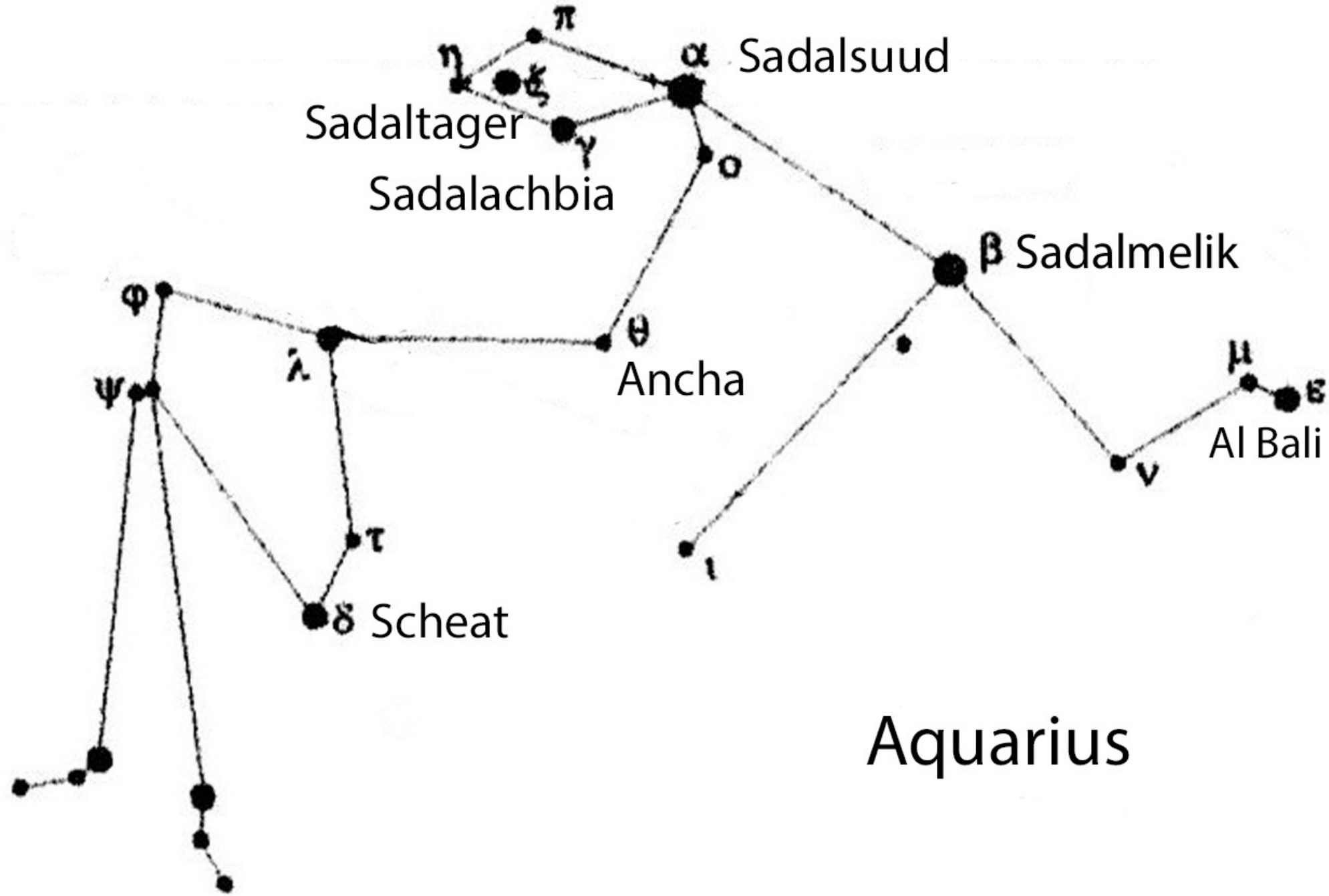
π
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Sadaltager
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Sadalachbia
β Sadalmelik
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Ancha
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Al Bali
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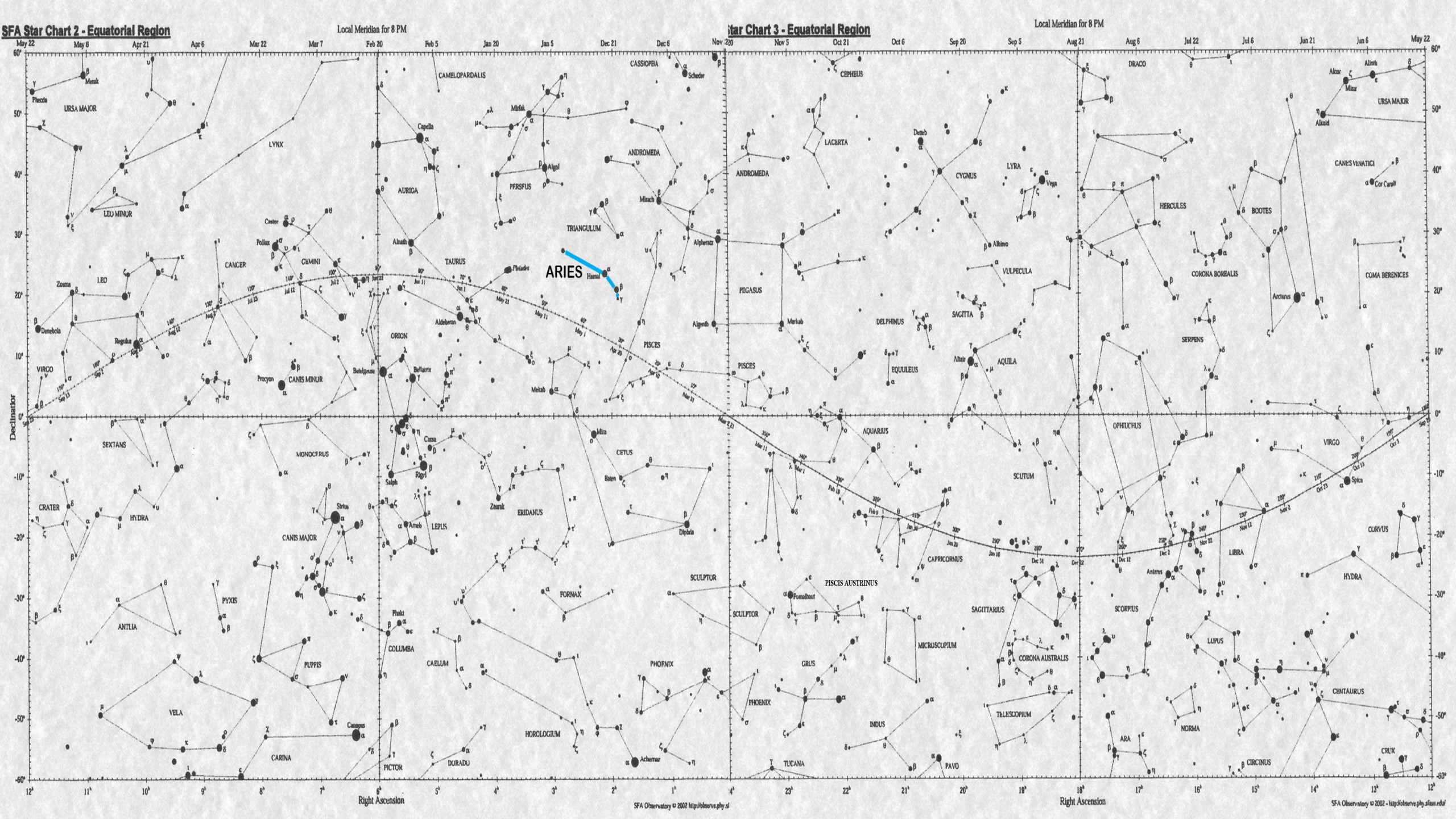
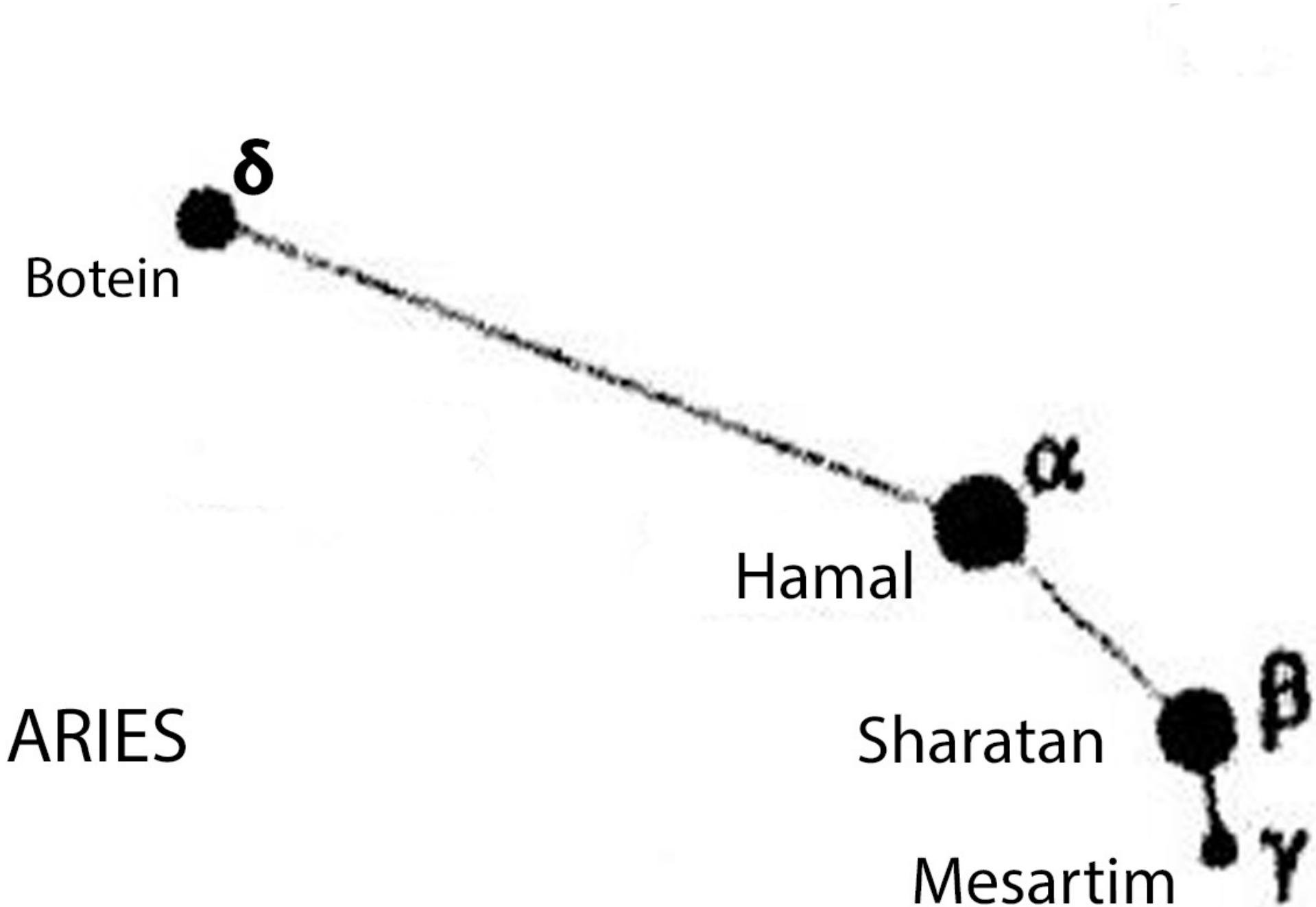
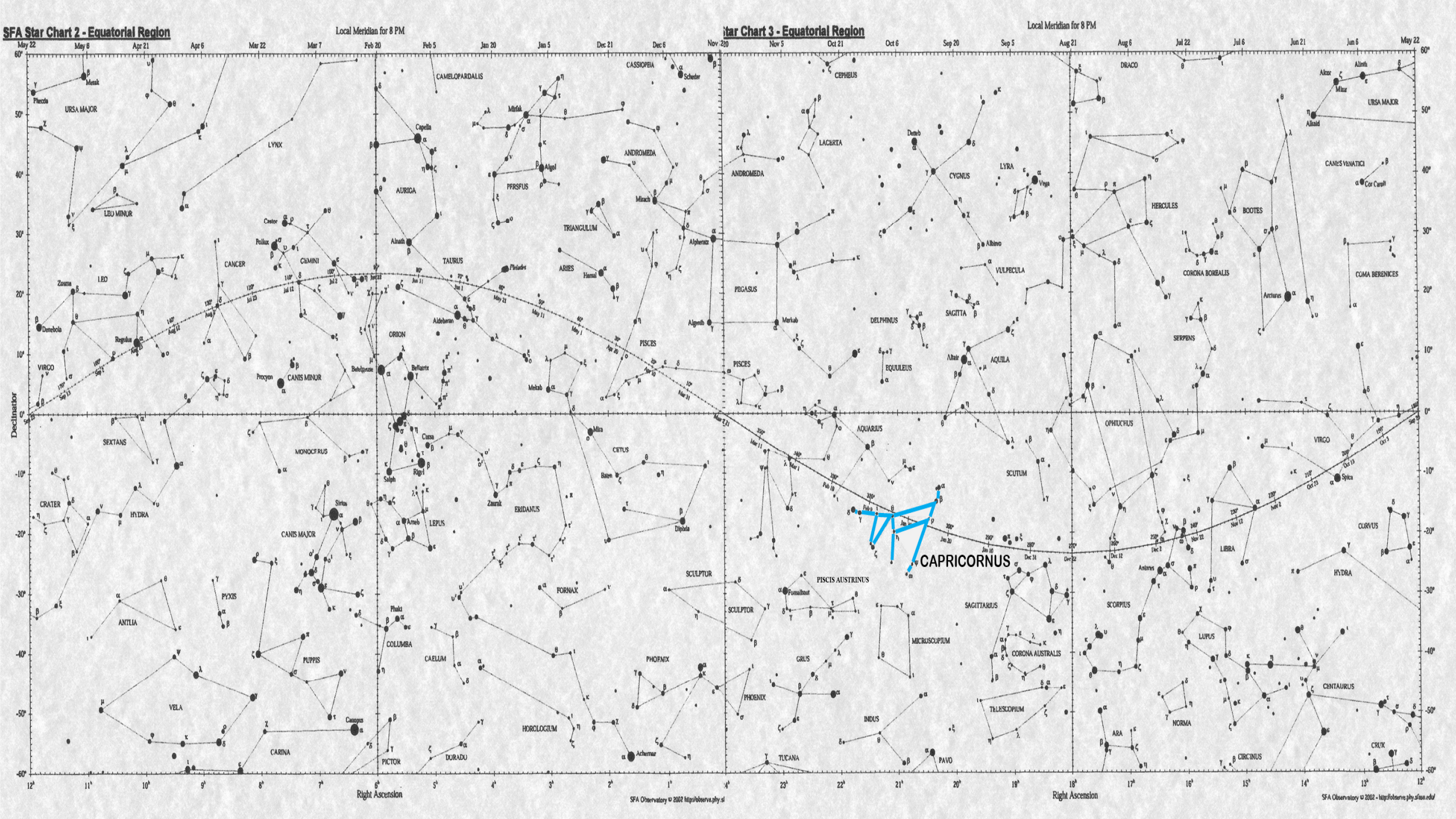
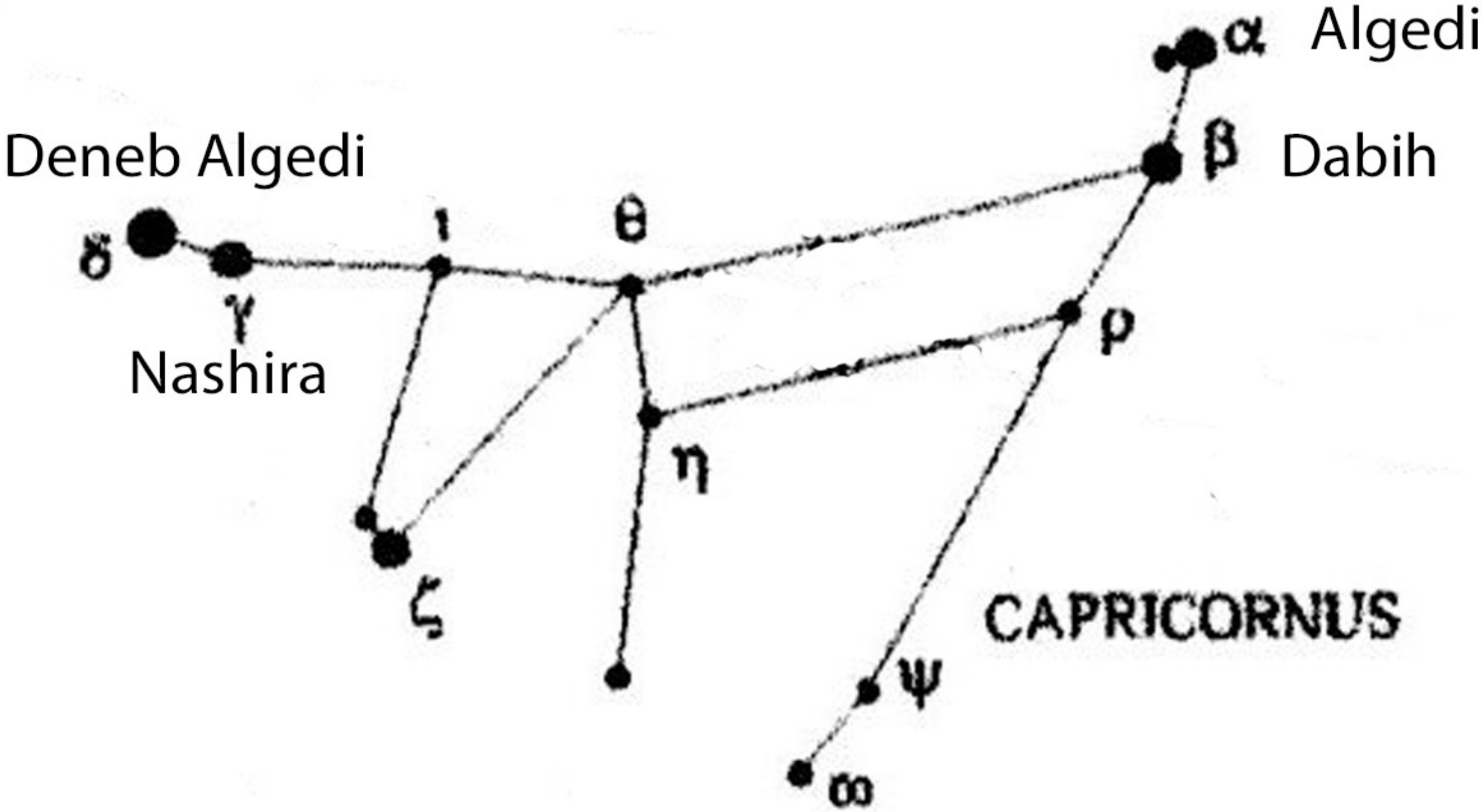
δ Scheat
Aquarius


SFA Star Chart 2 - Equatorial Region
Local Meridian for 8 PM
May 22
May 6
Apr 21
Apr 6
Mar 22
Mar 7
Feb 20
Feb 5
Jan 20
Jan 5
Dec 21
Dec 6
Nov 20
URSA MAJOR
LYNX
LEO MINOR
CAMELOPARDALIS
CASSIOPEIA
Schedar
Mirfak
Capella
Algol
PERSEUS
AURIGA
ANDROMEDA
Mirach
Alpheratz
Alnath
TRIANGULUM
ARIES
Hamal
Pleiades
Algenib
Castor
Pollux
CANCER
GEMINI
TAURUS
LEO
Zosma
Denebola
Regulus
Aldebaran
ORION
Betelgeuse
Bellatrix
PISCES
Mekab
VIRGO
Procyon
CANIS MINOR
Declination
SEXTANS
MONOCEROS
Cursa
Rigel
Saiph
CETUS
Mira
Baten
Diphda
CRATER
HYDRA
Sirius
Zaurak
ERIDANUS
CANIS MAJOR
Arneb
LEPUS
PYXIS
ANTLIA
FORNAX
SCULPTUR
PUPPIS
Phakt
COLUMBA
CAELUM
PHOENIX
VELA
Canopus
HOROLOGIUM
CARINA
Achernar
PICTOR
DORADU
-60°
-50°
-40°
-30°
-20°
-10°
0°
10°
20°
30°
40°
50°
60°
12h
11h
10h
9h
8h
7h
6h
5h
4h
3h
2h
1h
Right Ascension
SFA Observatory © 2002 http://observe.phy.sl
Star Chart 3 - Equatorial Region
Local Meridian for 8 PM
Nov 5
Oct 21
Oct 6
Sep 20
Sep 5
Aug 21
Aug 6
Jul 22
Jul 6
Jun 21
Jun 6
May 22
CEPHEUS
LACERTA
ANDROMEDA
Deneb
CYGNUS
LYRA
Vega
Albireo
VULPECULA
PEGASUS
Markab
DELPHINUS
SAGITTA
EQUULEUS
Altair
AQUILA
PISCES
AQUARIUS
SCUTUM
CAPRICORNUS
PISCIS AUSTRINUS
Fomalhaut
SCULPTOR
SAGITTARIUS
MICROSCOPIUM
GRUS
CORONA AUSTRALIS
PHOENIX
TELESCOPIUM
INDUS
TUCANA
PAVO
DRACO
Alcor
Mizar
Alioth
URSA MAJOR
Alkaid
CANES VENATICI
Cor Caroli
HERCULES
BOOTES
CORONA BOREALIS
Arcturus
COMA BERENICES
SERPENS
OPHIUCHUS
VIRGO
Spica
LIBRA
CURVUS
HYDRA
Antares
SCORPIUS
LUPUS
CENTAURUS
NORMA
ARA
CIRCINUS
CRUX
Right Ascension
SFA Observatory © 2002 - http://observe.phy.sfasu.edu/


δ
Botein
α
Hamal
β
Sharatan
γ
Mesartim
ARIES


SFA Star Chart 2 - Equatorial Region
Local Meridian for 8 PM
May 22
May 6
Apr 21
Apr 6
Mar 22
Mar 7
Feb 20
Feb 5
Jan 20
Jan 5
Dec 21
Dec 6
Nov 20
Nov 5
Oct 21
Oct 6
Sep 20
Sep 5
Aug 21
Aug 6
Jul 22
Jul 6
Jun 21
Jun 6
May 22
Declination
Right Ascension
URSA MAJOR
LYNX
LEO MINOR
CAMELOPARDALIS
CASSIOPEIA
Schedar
Mirfak
Algol
PERSEUS
Capella
AURIGA
ANDROMEDA
Mirach
Alpheratz
TRIANGULUM
Alnath
TAURUS
Pleiades
ARIES
Hamal
Algenib
PISCES
Aldebaran
ORION
Betelgeuse
Bellatrix
Mekab
CANCER
GEMINI
Castor
Pollux
LEO
Zosma
Denebola
Regulus
VIRGO
Procyon
CANIS MINOR
SEXTANS
MONOCEROS
CRATER
HYDRA
Sirius
CANIS MAJOR
Cursa
Rigel
Saiph
Arneb
LEPUS
ERIDANUS
Zaurak
Mira
CETUS
Baten
Diphda
ANTLIA
PYXIS
PUPPIS
VELA
Canopus
CARINA
Phakt
COLUMBA
CAELUM
PICTOR
DORADO
FORNAX
SCULPTOR
HOROLOGIUM
PHOENIX
Achernar
CEPHEUS
LACERTA
ANDROMEDA
Deneb
CYGNUS
LYRA
Vega
Albireo
VULPECULA
PEGASUS
Markab
DELPHINUS
SAGITTA
EQUULEUS
Altair
AQUILA
PISCES
AQUARIUS
SCUTUM
CAPRICORNUS
PISCIS AUSTRINUS
Fomalhaut
SCULPTOR
MICROSCOPIUM
GRUS
PHOENIX
INDUS
TUCANA
PAVO
SAGITTARIUS
CORONA AUSTRALIS
TELESCOPIUM
SFA Observatory © 2002 http://observe.phy.sf
SFA Star Chart 3 - Equatorial Region
Local Meridian for 8 PM
DRACO
Alkaid
Alioth
Mizar
Alcor
URSA MAJOR
CANES VENATICI
Cor Caroli
HERCULES
BOOTES
CORONA BOREALIS
Arcturus
COMA BERENICES
SERPENS
OPHIUCHUS
VIRGO
Spica
LIBRA
CORVUS
HYDRA
SCORPIUS
Antares
LUPUS
CENTAURUS
NORMA
ARA
CRUX
CIRCINUS
Right Ascension
SFA Observatory © 2002 - http://observe.phy.sfasu.edu/


α
Algedi
Deneb Algedi
β
Dabih
δ
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Nashira
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CAPRICORNUS
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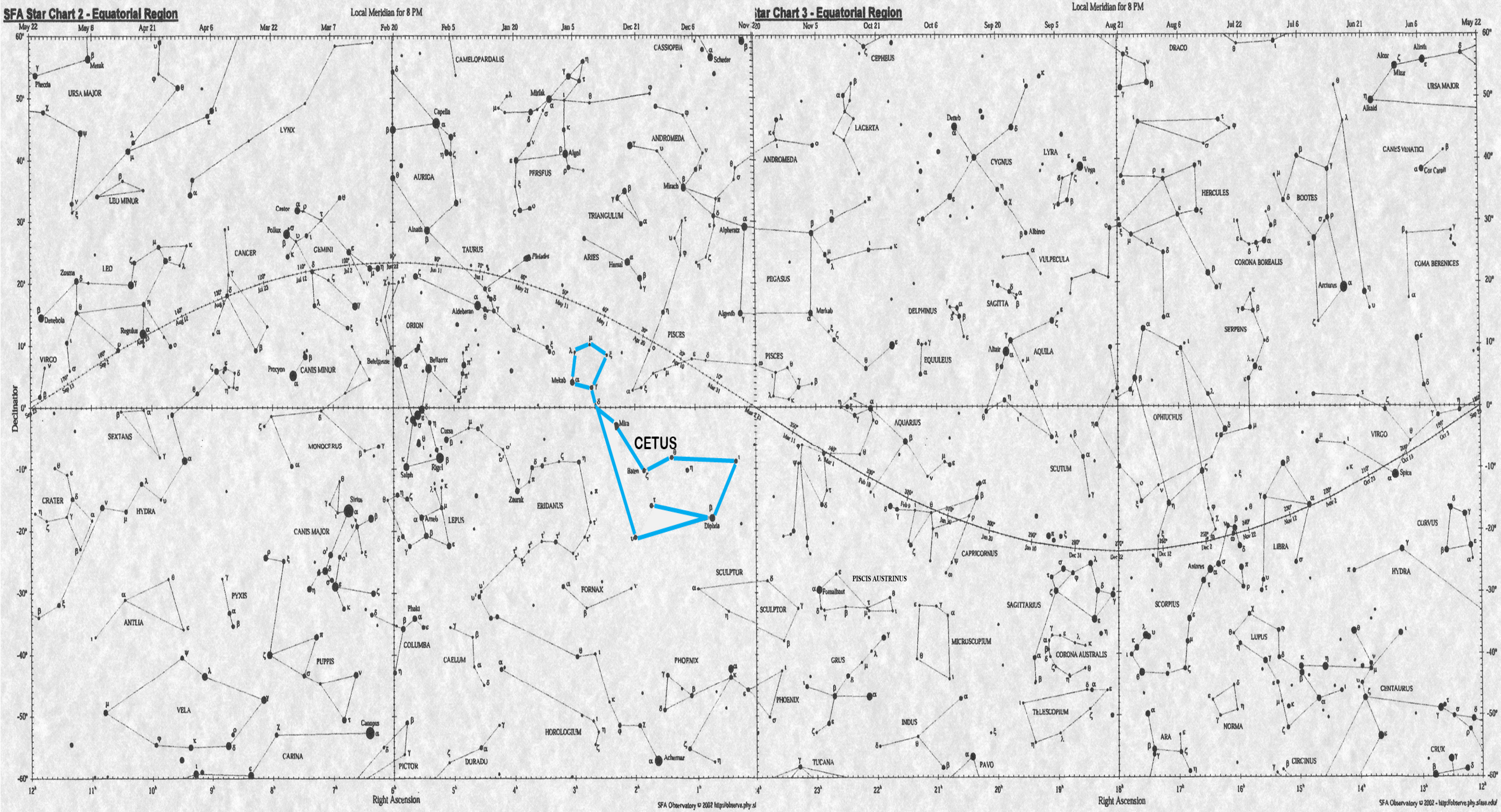
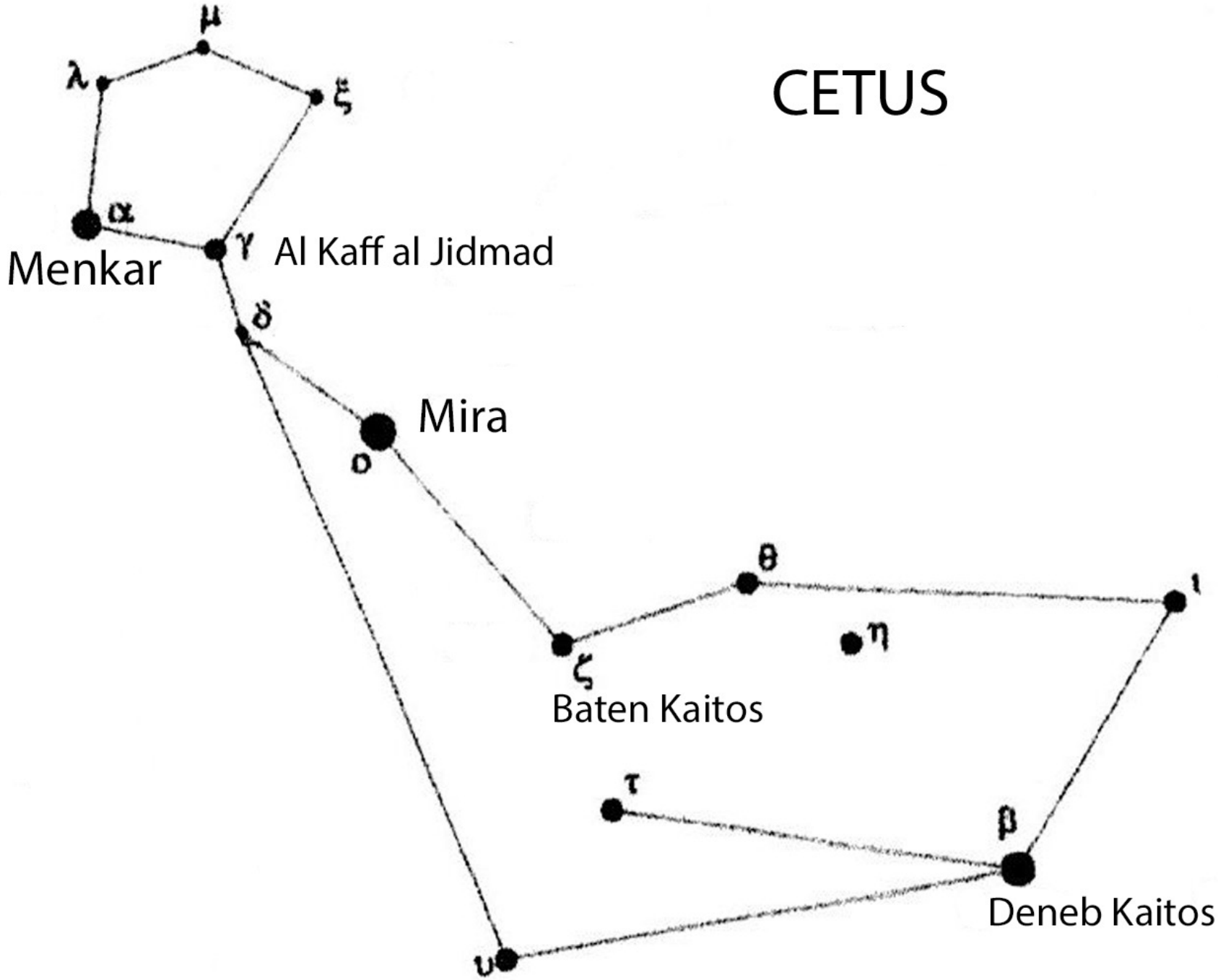

SFA Star Chart 2 - Equatorial Region
Local Meridian for 8 PM
Star Chart 3 - Equatorial Region
Local Meridian for 8 PM
CETUS
Mira
Baten
Diphda
Menkab
URSA MAJOR
LYNX
LEO MINOR
CAMELOPARDALIS
CASSIOPEIA
PERSEUS
AURIGA
ANDROMEDA
TRIANGULUM
ARIES
TAURUS
GEMINI
CANCER
LEO
VIRGO
ORION
CANIS MINOR
PISCES
SEXTANS
MONOCEROS
CRATER
HYDRA
CANIS MAJOR
LEPUS
ERIDANUS
FORNAX
SCULPTOR
PYXIS
ANTLIA
PUPPIS
COLUMBA
CAELUM
PHOENIX
VELA
CARINA
PICTOR
DORADO
HOROLOGIUM
CEPHEUS
LACERTA
CYGNUS
LYRA
DRACO
HERCULES
BOOTES
CANES VENATICI
PEGASUS
DELPHINUS
SAGITTA
VULPECULA
CORONA BOREALIS
SERPENS
COMA BERENICES
EQUULEUS
AQUILA
AQUARIUS
SCUTUM
OPHIUCHUS
CAPRICORNUS
LIBRA
CORVUS
PISCIS AUSTRINUS
SAGITTARIUS
SCORPIUS
MICROSCOPIUM
GRUS
CORONA AUSTRALIS
LUPUS
CENTAURUS
INDUS
TELESCOPIUM
NORMA
ARA
TUCANA
PAVO
CIRCINUS
CRUX
Declination
Right Ascension
SFA Observatory © 2002 http://observe.phy.sfasu.edu/

CETUS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Baten Kaitos
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Deneb Kaitos
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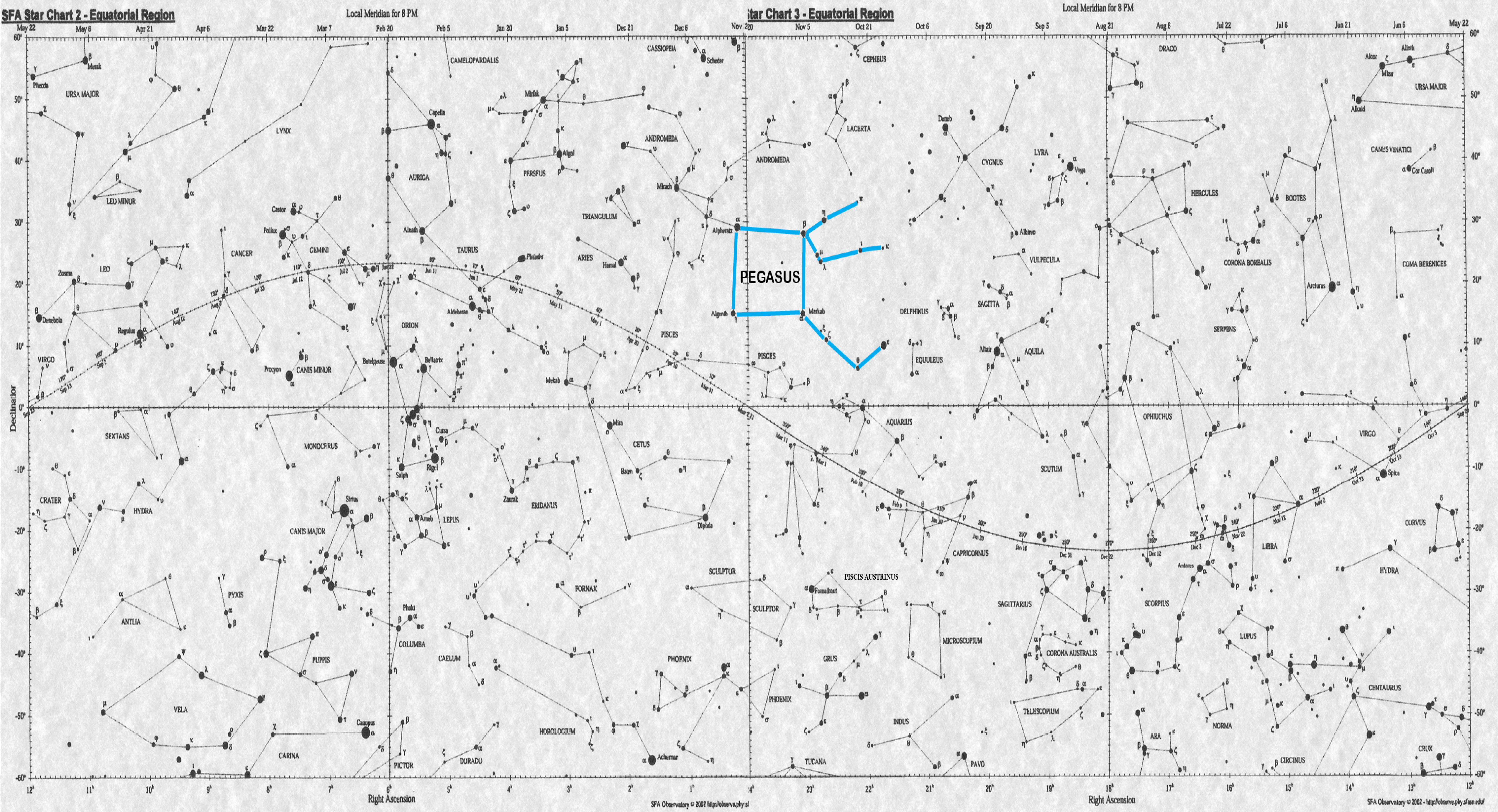
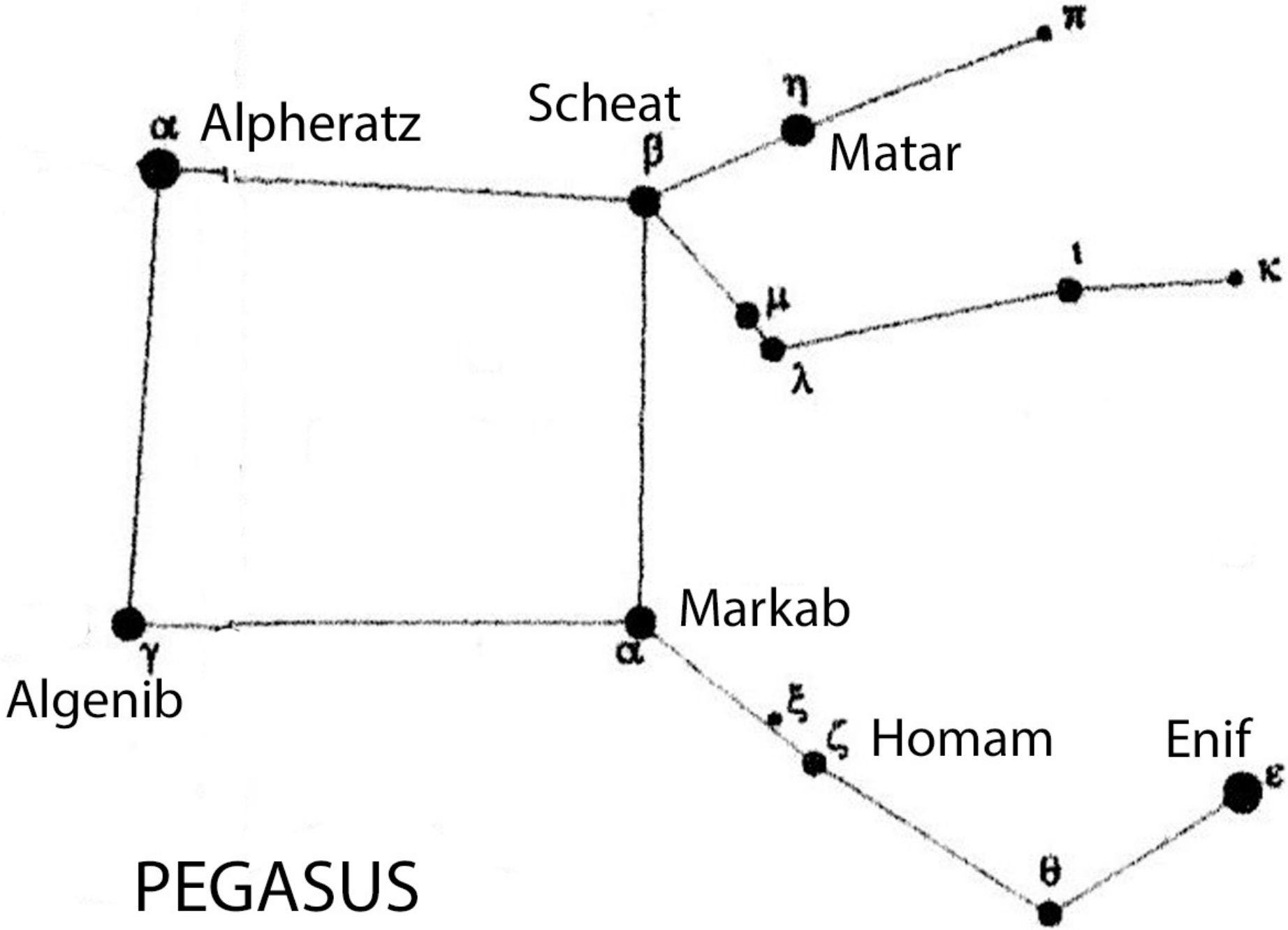

SFA Star Chart 2 - Equatorial Region
Star Chart 3 - Equatorial Region
Local Meridian for 8 PM
Local Meridian for 8 PM
URSA MAJOR
LEO MINOR
LYNX
CAMELOPARDALIS
CASSIOPEIA
CEPHEUS
DRACO
URSA MAJOR
AURIGA
PERSEUS
ANDROMEDA
ANDROMEDA
LACERTA
CYGNUS
LYRA
CANES VENATICI
HERCULES
BOOTES
TRIANGULUM
PEGASUS
CORONA BOREALIS
COMA BERENICES
CANCER
GEMINI
TAURUS
ARIES
PISCES
VULPECULA
LEO
SAGITTA
DELPHINUS
SERPENS
ORION
AQUILA
EQUULEUS
VIRGO
CANIS MINOR
PISCES
SEXTANS
MONOCERUS
CETUS
AQUARIUS
OPHIUCHUS
VIRGO
SCUTUM
CRATER
HYDRA
CANIS MAJOR
LEPUS
ERIDANUS
CAPRICORNUS
LIBRA
CORVUS
SCULPTOR
PISCIS AUSTRINUS
PYXIS
FORNAX
SCULPTOR
SAGITTARIUS
SCORPIUS
HYDRA
ANTLIA
COLUMBA
MICROSCOPIUM
LUPUS
PUPPIS
CAELUM
PHOENIX
GRUS
CORONA AUSTRALIS
CENTAURUS
VELA
PHOENIX
INDUS
TELESCOPIUM
NORMA
HOROLOGIUM
ARA
CARINA
PICTOR
DORADO
TUCANA
PAVO
CIRCINUS
CRUX
Declination
Right Ascension
Right Ascension
SFA Observatory © 2002 http://observe.phy.sfasu.edu/


α Alpheratz
Scheat
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Markab
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Algenib
ξ
ζ Homam
Enif
ε
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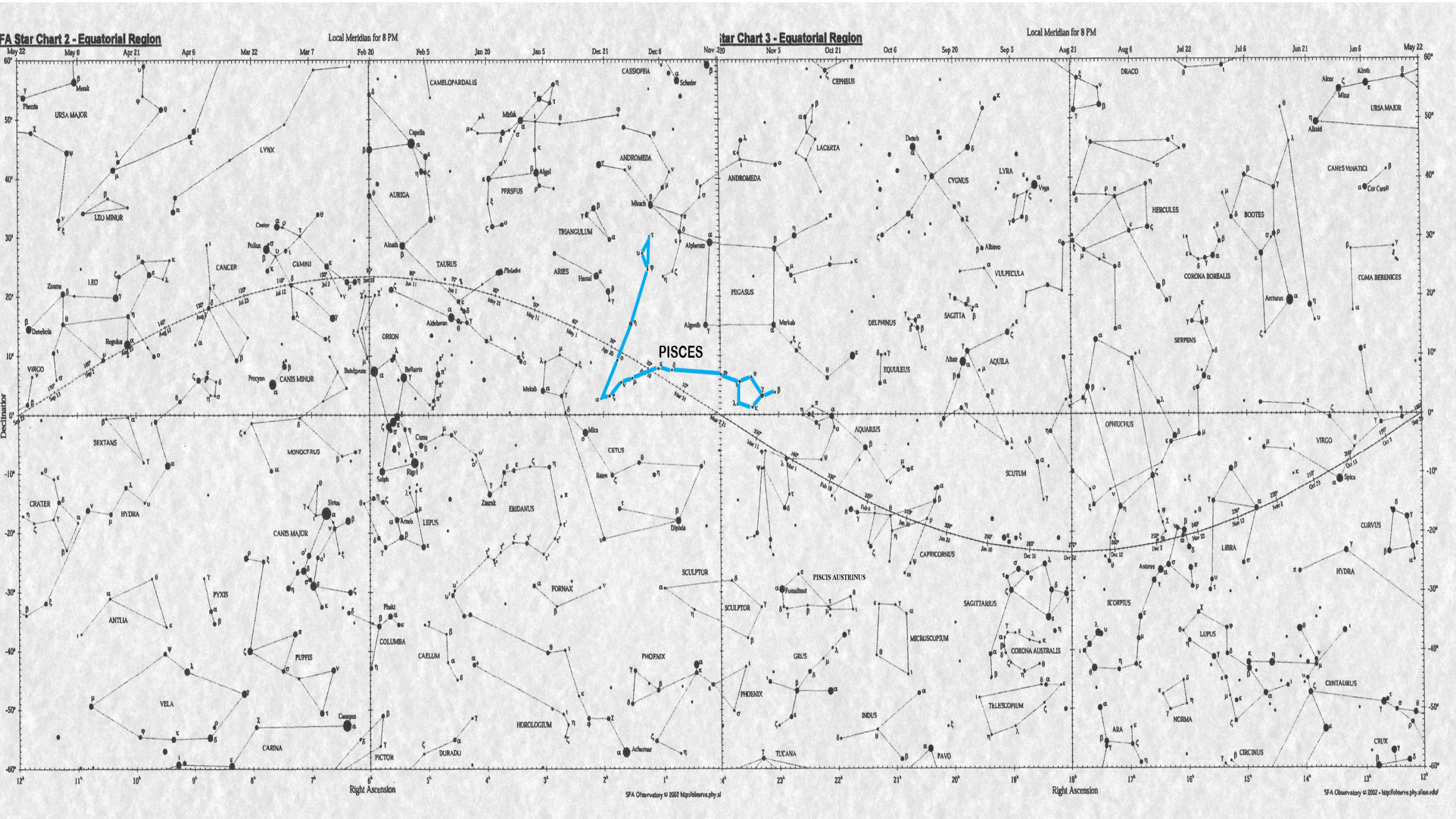
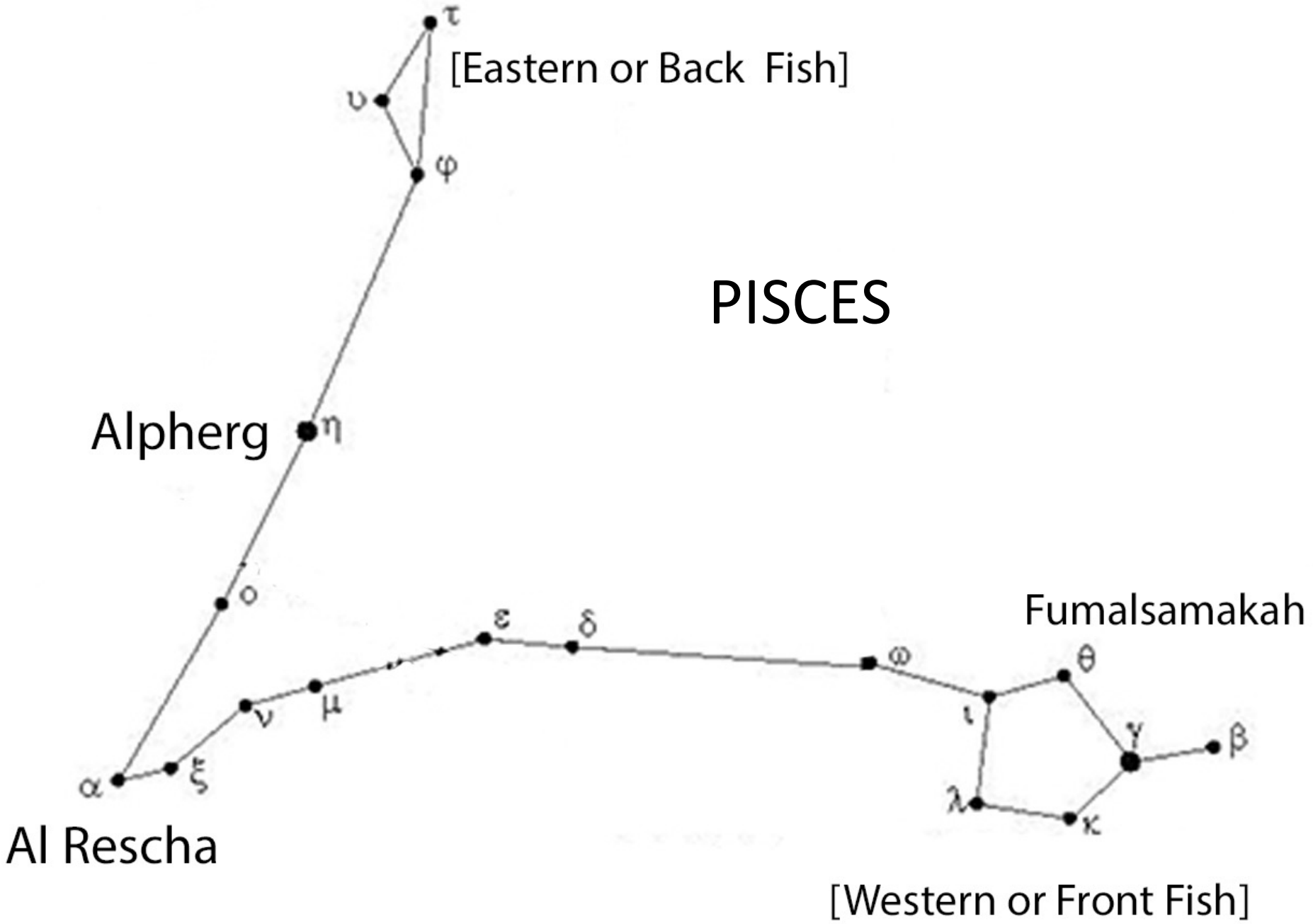
PEGASUS


FA Star Chart 2 - Equatorial Region
Local Meridian for 8 PM
tar Chart 3 - Equatorial Region
Local Meridian for 8 PM
PISCES
PISCIS AUSTRINUS
URSA MAJOR
LYNX
LEO MINOR
CAMELOPARDALIS
CASSIOPEIA
CEPHEUS
DRACO
ANDROMEDA
AURIGA
PERSEUS
TRIANGULUM
ARIES
TAURUS
CANCER
GEMINI
LEO
VIRGO
ORION
CANIS MINOR
CANIS MAJOR
LACERTA
CYGNUS
LYRA
VULPECULA
PEGASUS
DELPHINUS
SAGITTA
EQUULEUS
AQUILA
HERCULES
BOOTES
CORONA BOREALIS
SERPENS
CANES VENATICI
COMA BERENICES
AQUARIUS
CAPRICORNUS
SCUTUM
OPHIUCHUS
VIRGO
LIBRA
SCORPIUS
SAGITTARIUS
CORONA AUSTRALIS
TELESCOPIUM
MICROSCOPIUM
GRUS
PHOENIX
INDUS
TUCANA
PAVO
SCULPTOR
FORNAX
CETUS
ERIDANUS
HYDRA
CRATER
SEXTANS
MONOCEROS
PYXIS
ANTLIA
PUPPIS
VELA
CARINA
COLUMBA
CAELUM
PICTOR
DORADO
HOROLOGIUM
LEPUS
CRVUS
CENTAURUS
LUPUS
NORMA
ARA
CIRCINUS
CRUX
Declination
Right Ascension
SFA Observatory © 2002 http://observe.phy.sf
SFA Observatory © 2002 - http://observe.phy.sfasu.edu/


τ
[Eastern or Back Fish]
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PISCES
Alpherg
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Fumalsamakah
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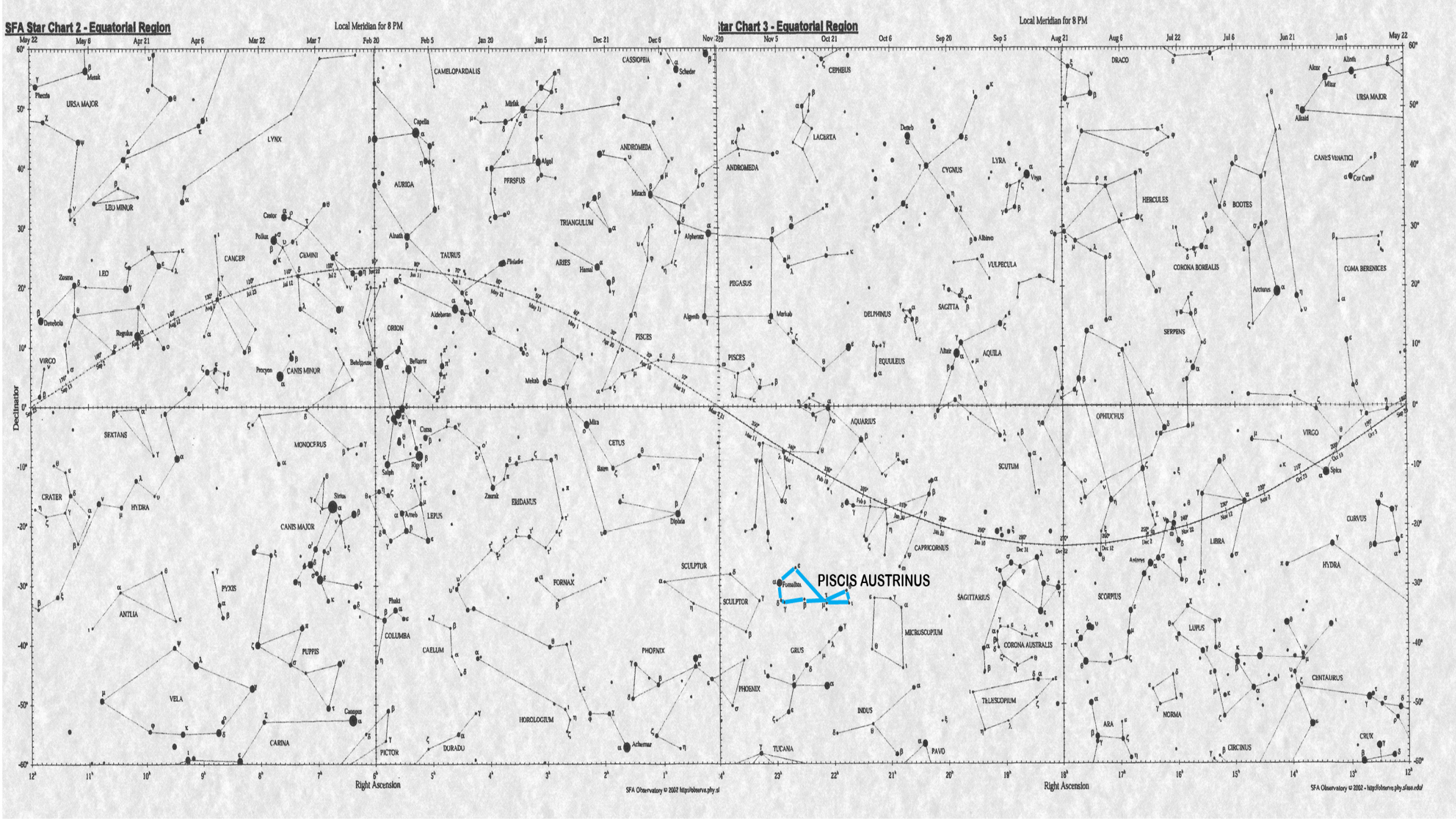
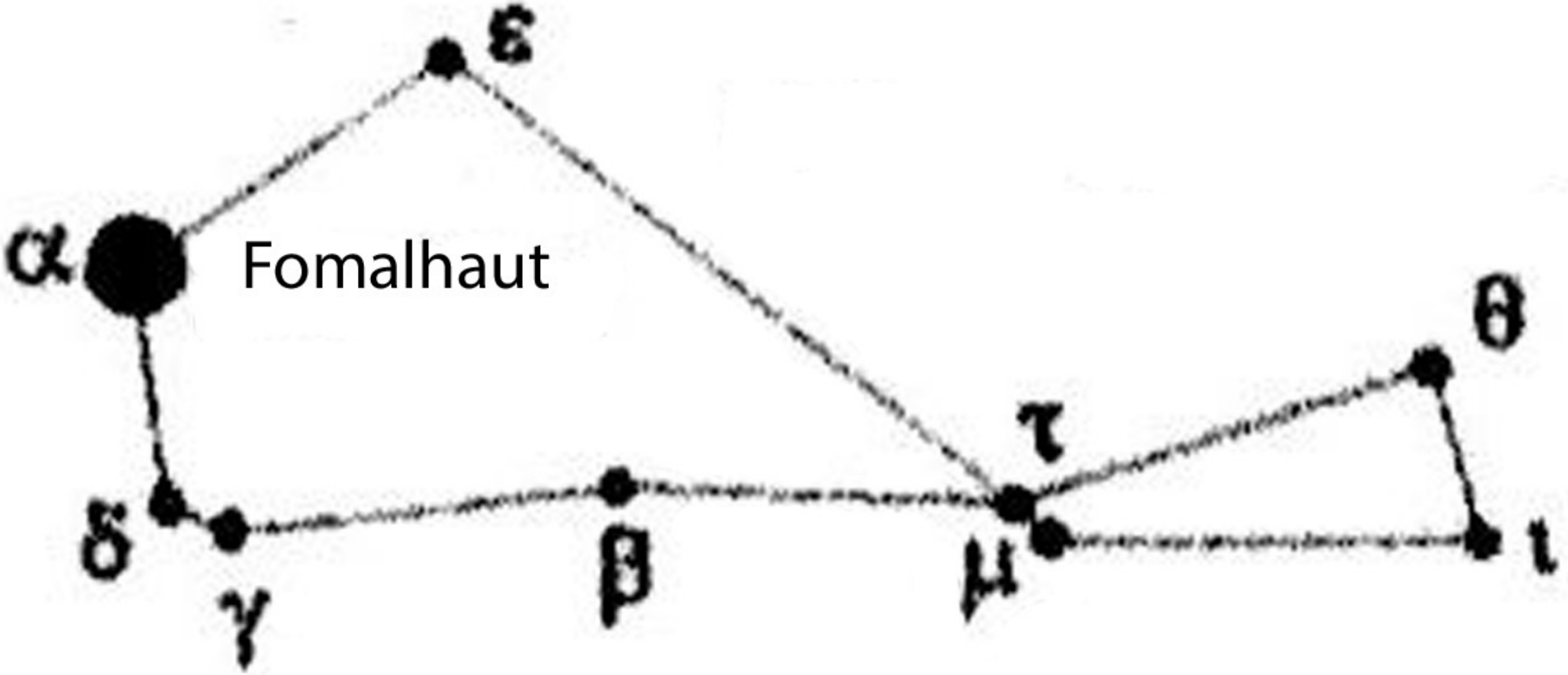
ν
γ
β
ξ
α
λ
κ
Al Rescha
[Western or Front Fish]

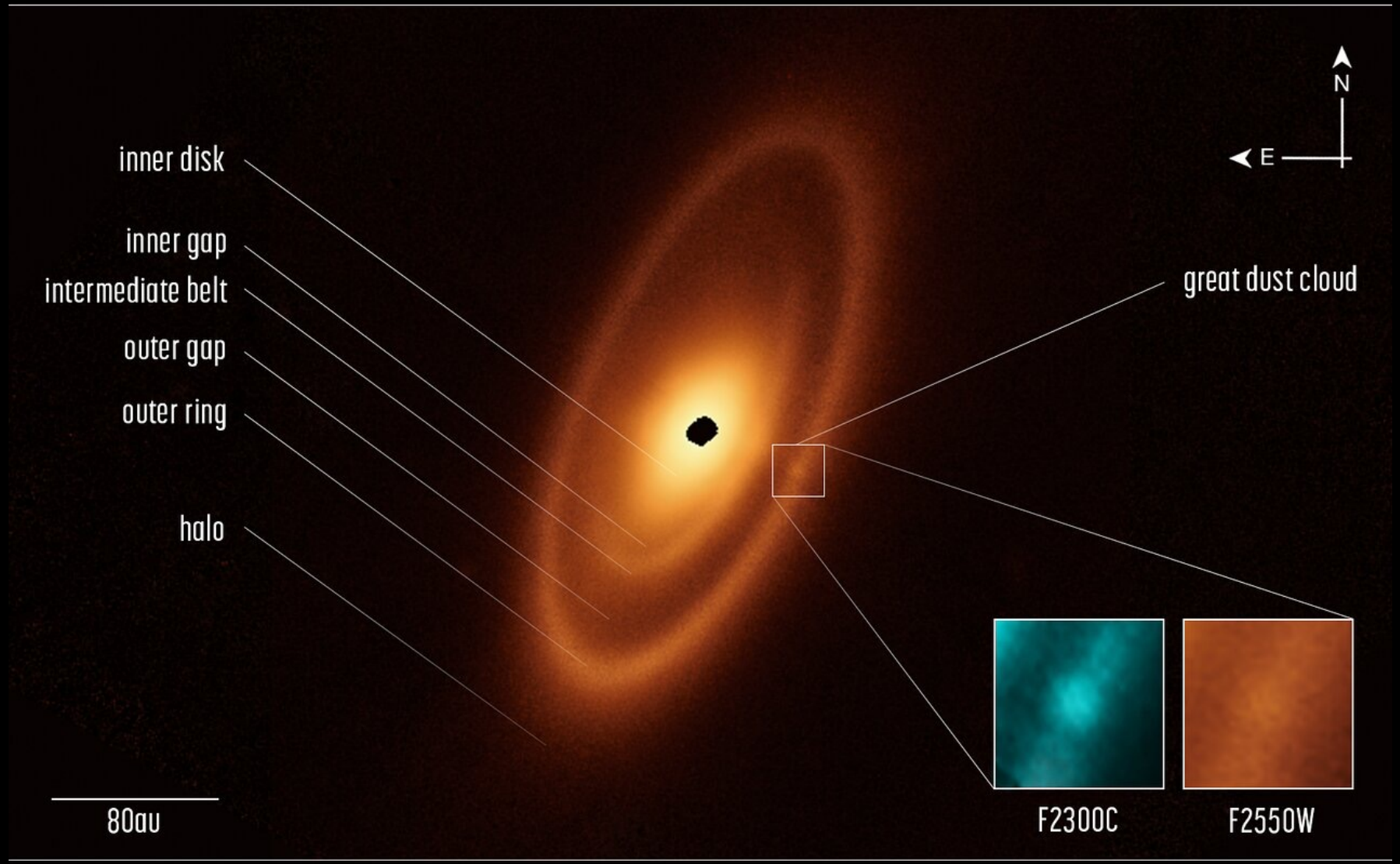

SFA Star Chart 2 - Equatorial Region
Local Meridian for 8 PM
Star Chart 3 - Equatorial Region
Local Meridian for 8 PM
PISCIS AUSTRINUS
Declination
Right Ascension
Right Ascension
SFA Observatory © 2002 http://observe.phy.sfasu.edu/
SFA Observatory © 2002 - http://observe.phy.sfasu.edu/

PISCIS AUSTRINUS

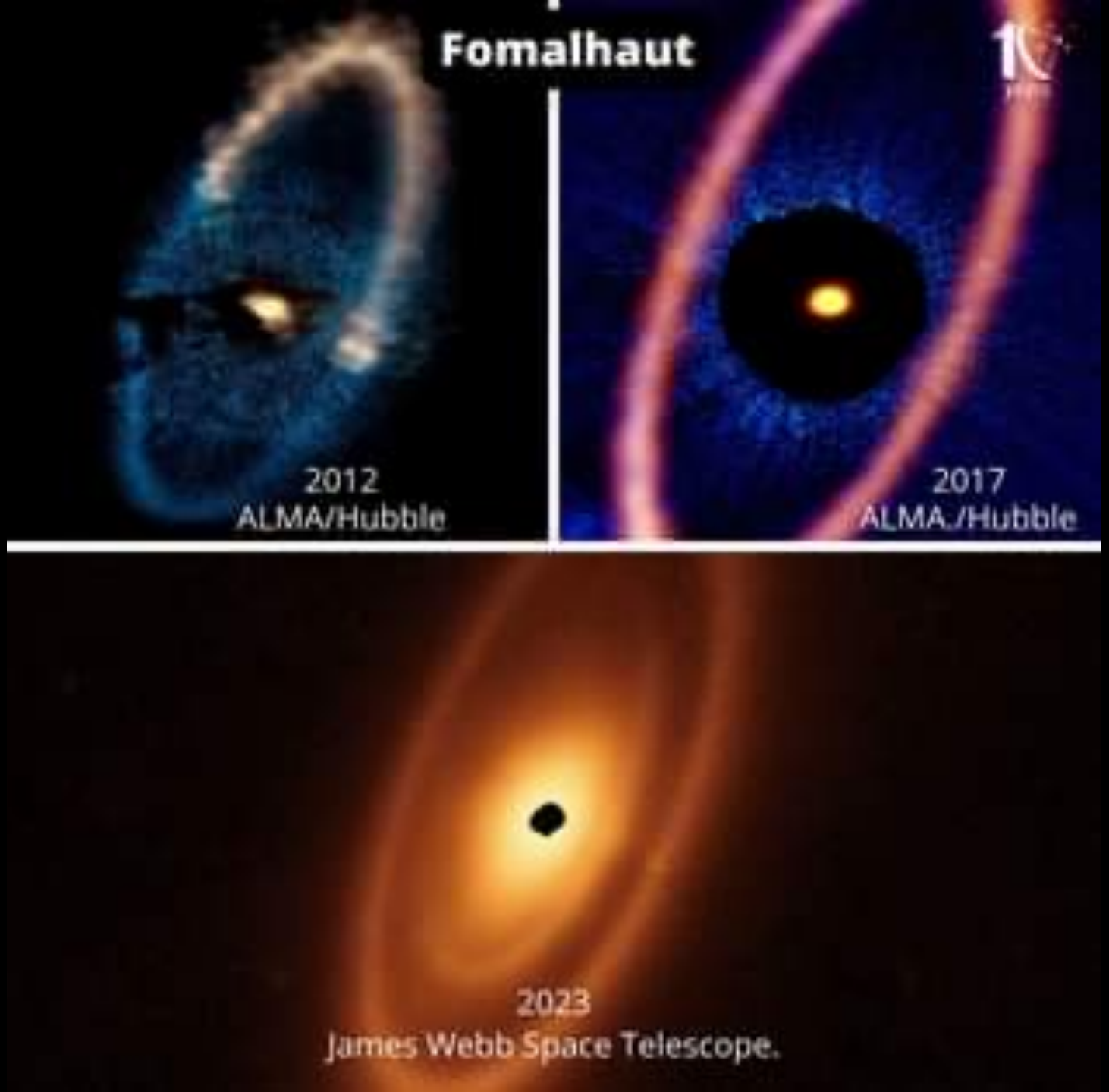


JAMES WEBB SPACE TELESCOPE

FOMALHAUT



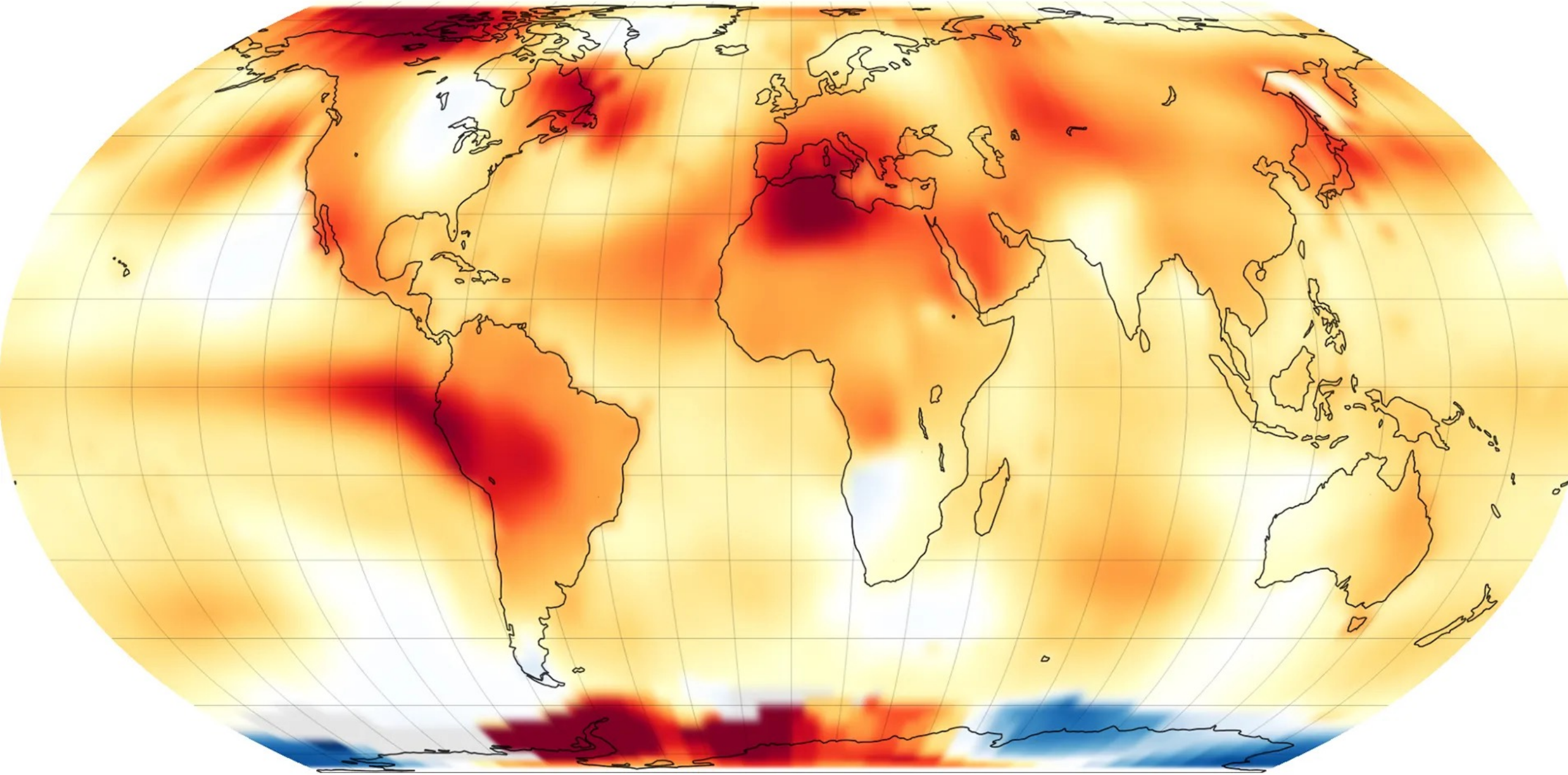
MIRI Filters | F2550W


Fomalhaut
2012
ALMA/Hubble
2017
ALMA./Hubble
2023
James Webb Space Telescope.

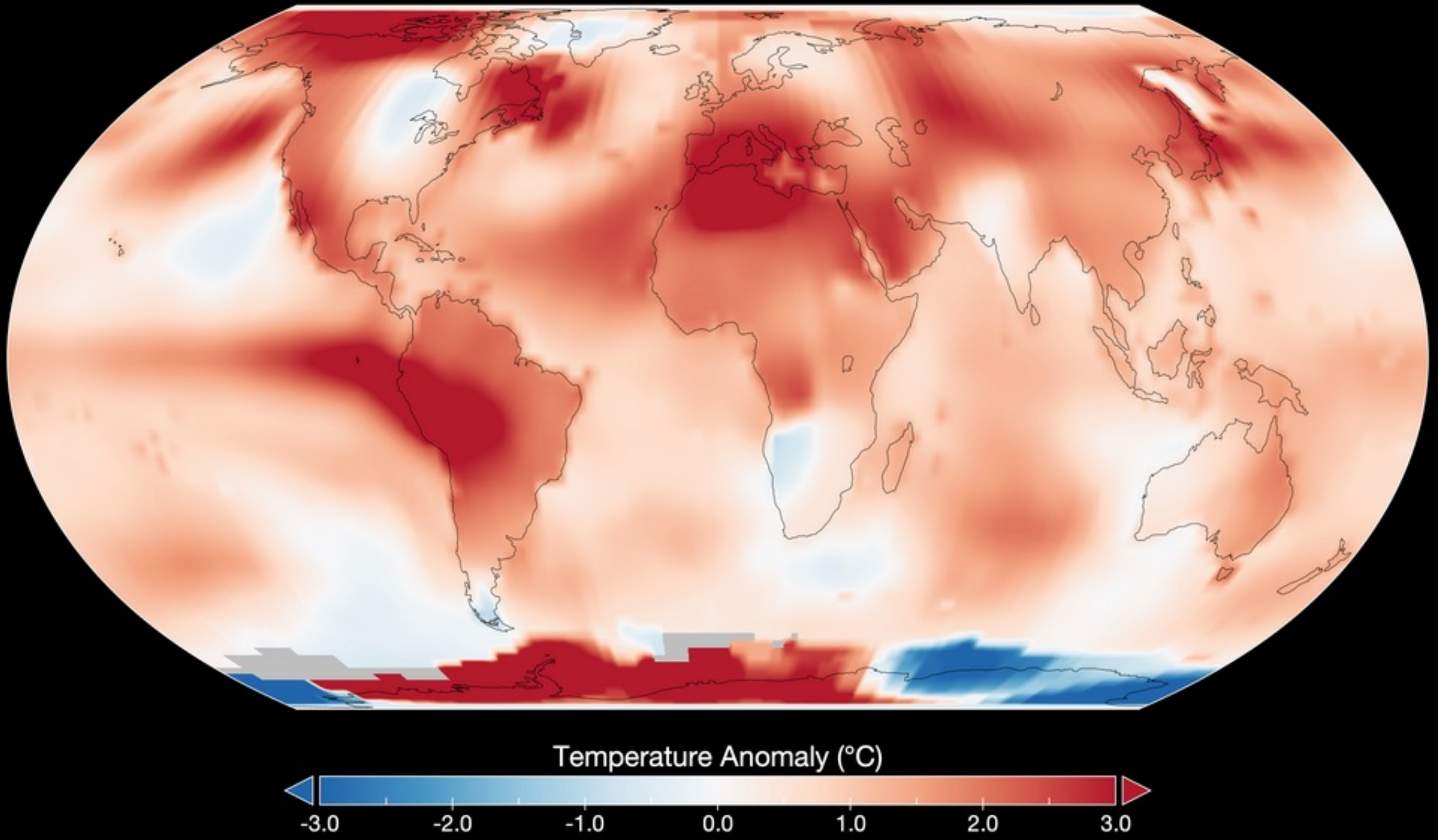
CLIMATE

VS

WEATHER

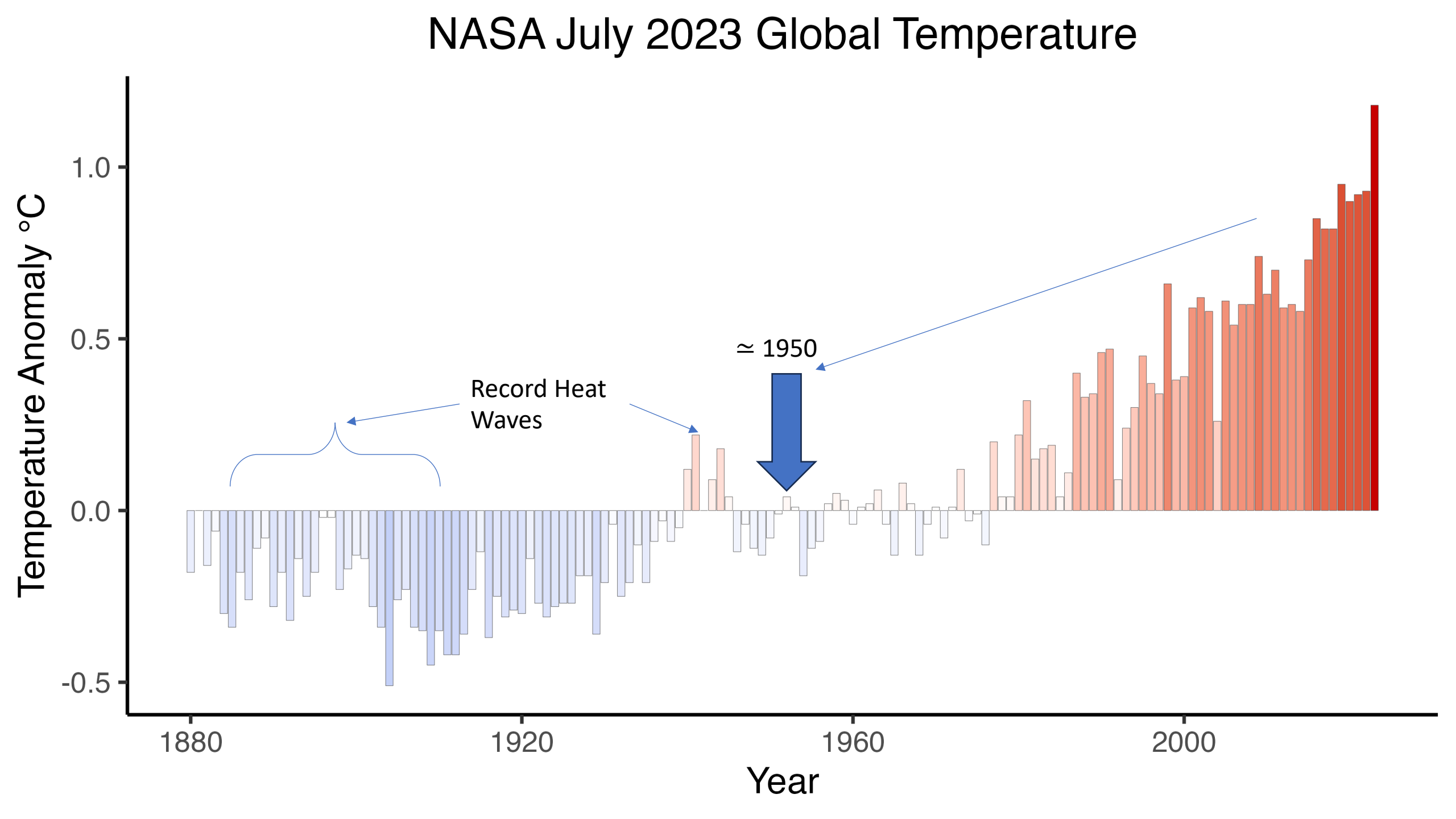


Global Temperature in July 2023 NASA: via various news agencies

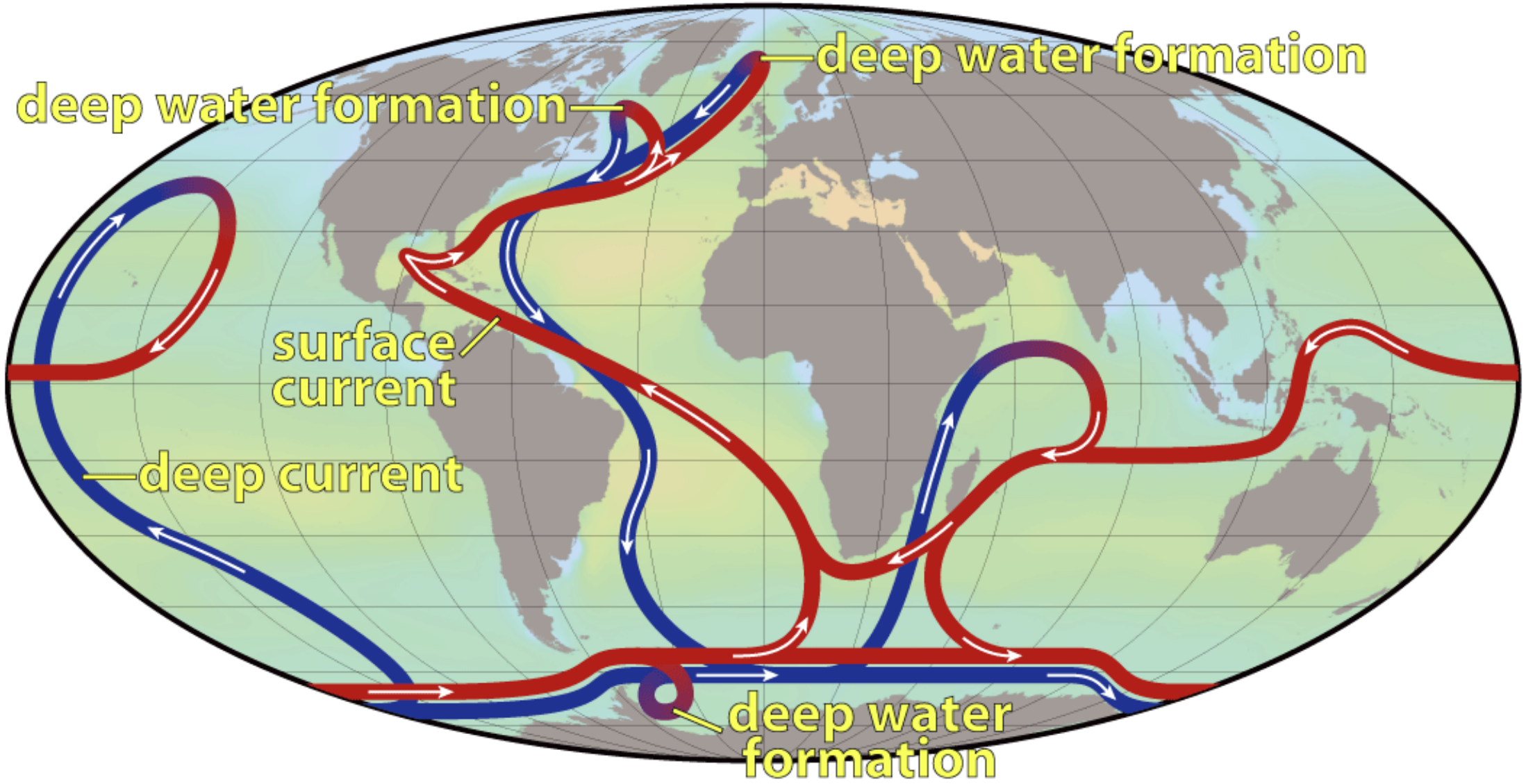


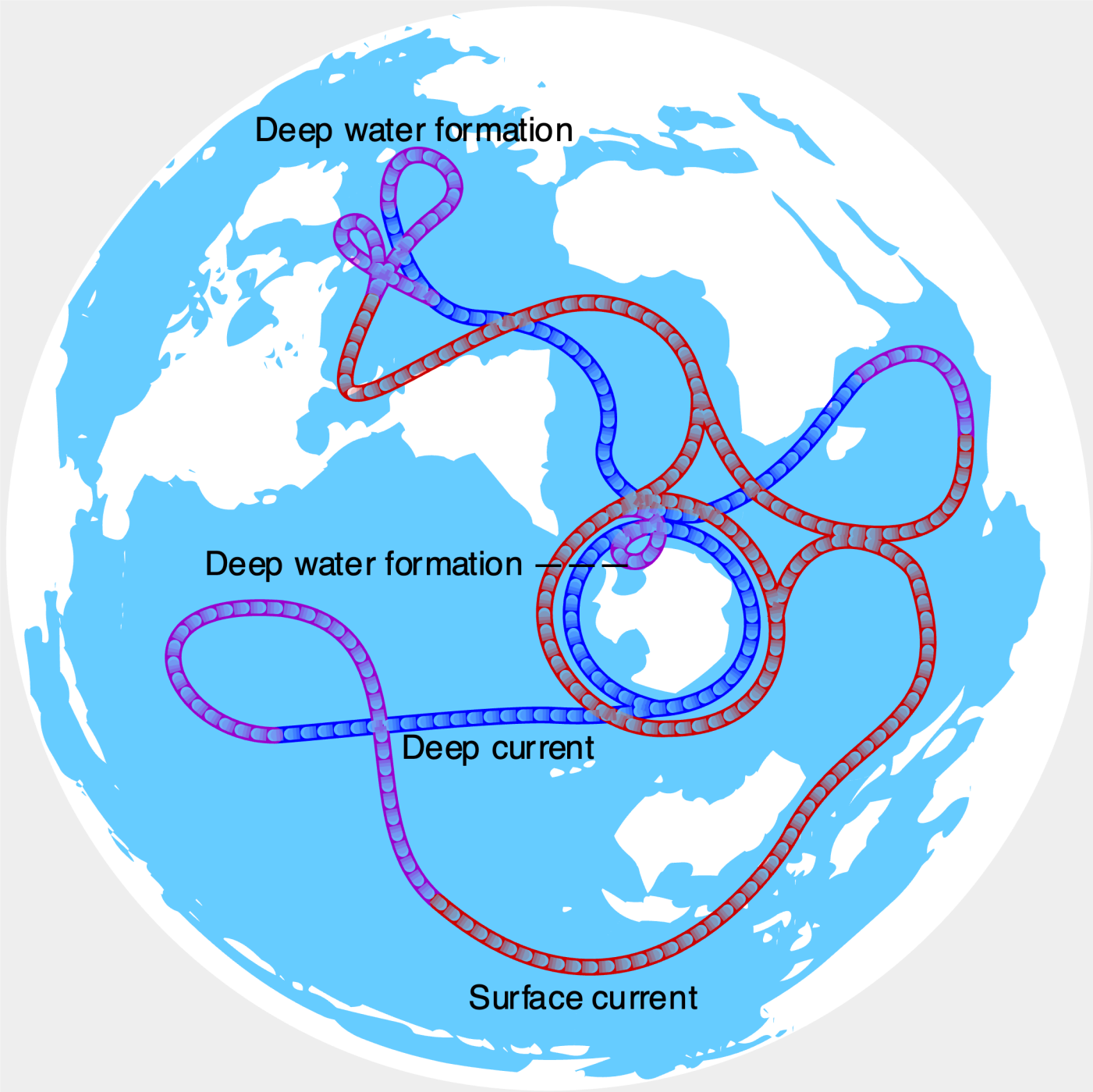
Temperature anomalies reflect how July 2023 compared to the average July temperature from 1951-1980.

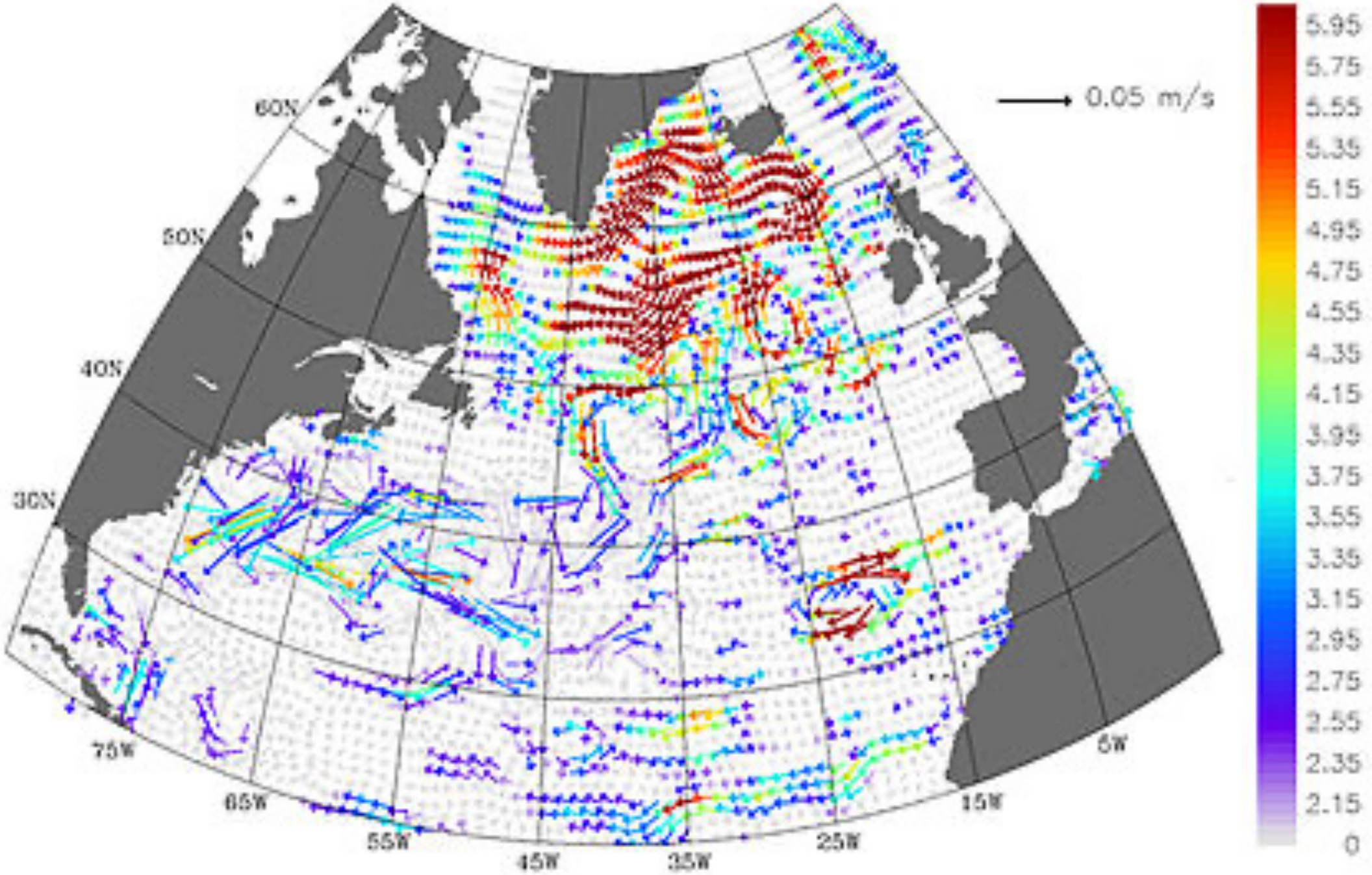
Credits: NASA's Goddard Institute for Space Studies


NASA July 2023 Global Temperature
Temperature Anomaly °C
1.0
0.5
0.0
-0.5
1880
1920
1960
2000
Year
≃ 1950
Record Heat
Waves

Thermohaline Circulation

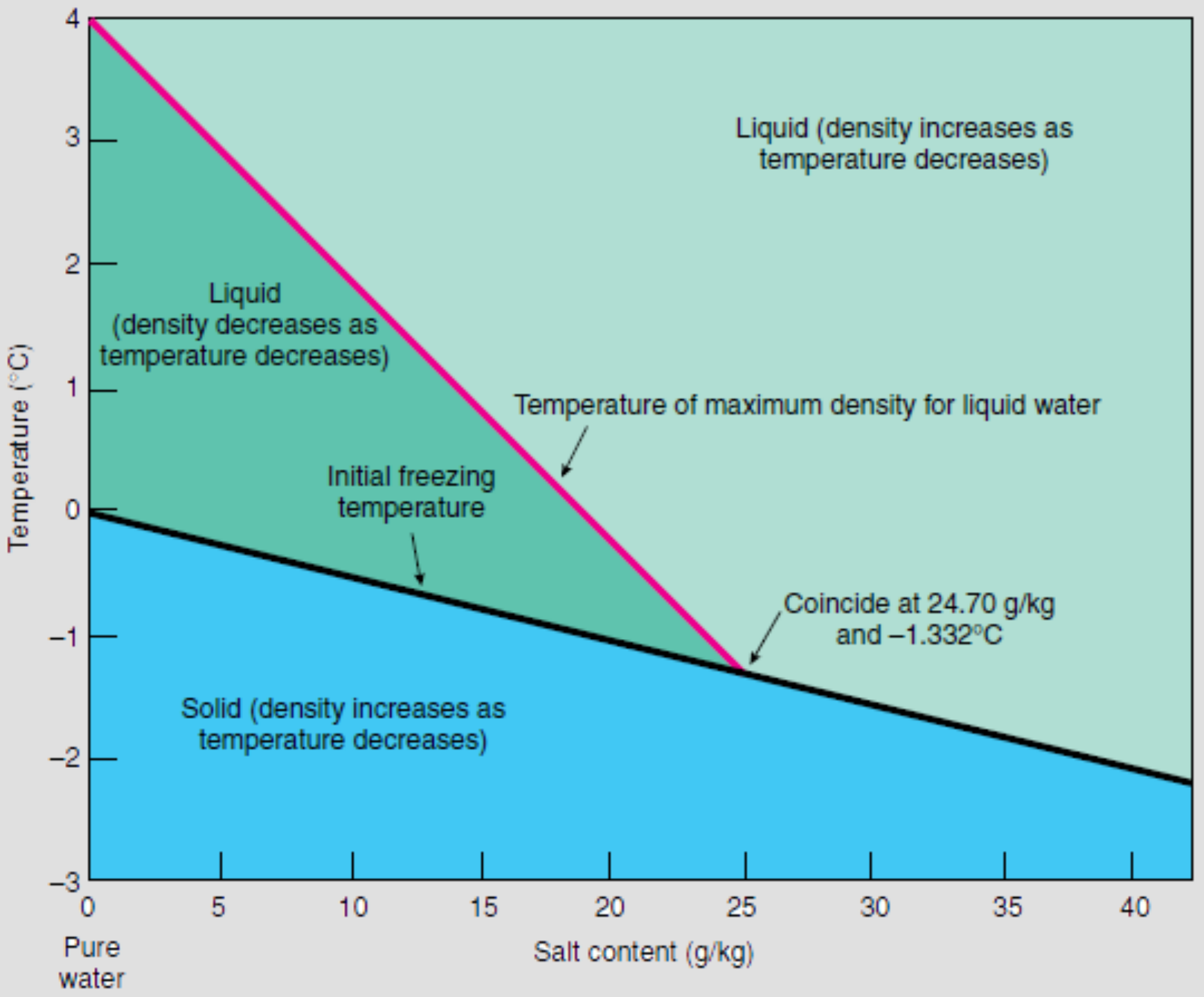



Deep water formation
Deep water formation
Deep current
Surface current



SLOWING
Of
AMOC

NASA


Liquid (density increases as temperature decreases)
Liquid (density decreases as temperature decreases)
Temperature of maximum density for liquid water
Initial freezing temperature
Coincide at 24.70 g/kg and –1.332°C
Solid (density increases as temperature decreases)
Temperature (°C)
4
3
2
1
0
–1
–2
–3
0
5
10
15
20
25
30
35
40
Pure water
Salt content (g/kg)

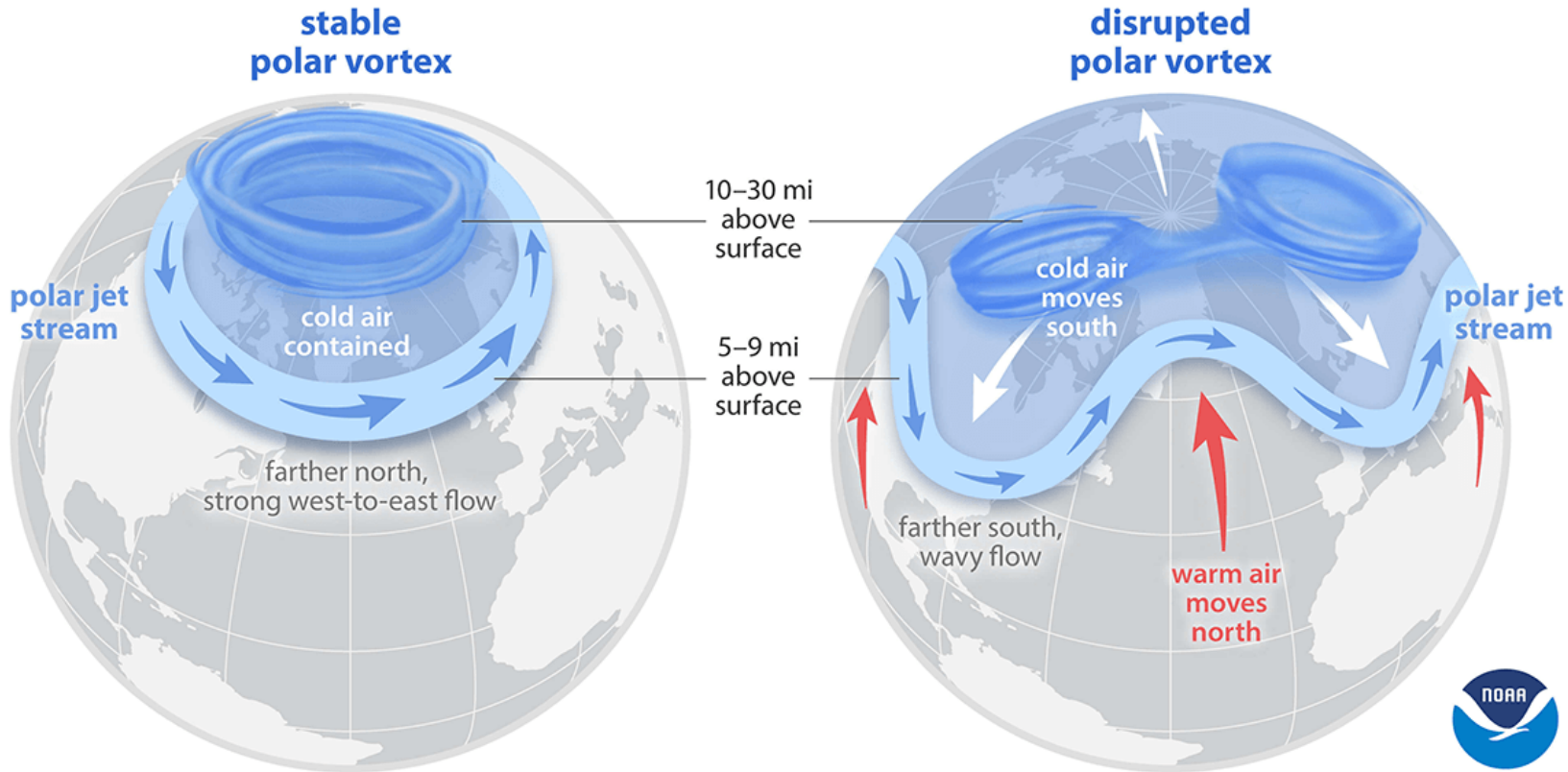
Break down of the Polar Vortex

Understanding the polar vortex

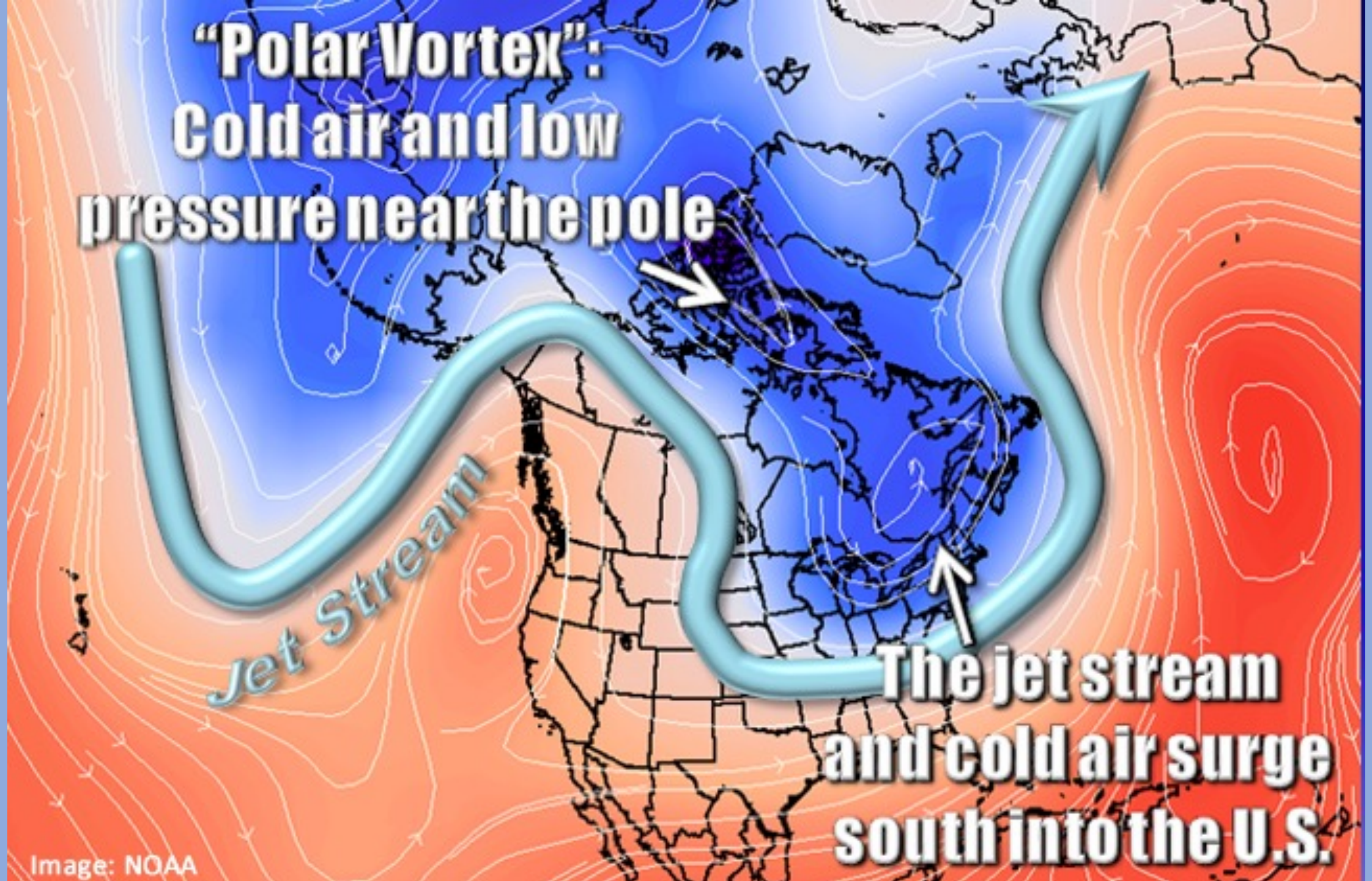
The Arctic polar vortex is a strong band of winds in the stratosphere, surrounding the North Pole 10–30 miles above the surface.

The polar vortex is far above and typically does not interact with the polar jet stream, the flow of winds in the troposphere 5–9 miles above the surface. But when the polar vortex is especially strong and stable, the jet stream stays farther north and has fewer "kinks." This keeps cold air contained over the Arctic and the mid-latitudes warmer than usual.

Every other year or so, the Arctic polar vortex dramatically weakens. The vortex can be pushed off the pole or split into two. Sometimes the polar jet stream mirrors this stratospheric upheaval, becoming weaker or wavy. At the surface, cold air is pushed southward to the mid-latitudes, and warm air is drawn up into the Arctic.



NOAA Climate.gov
2021

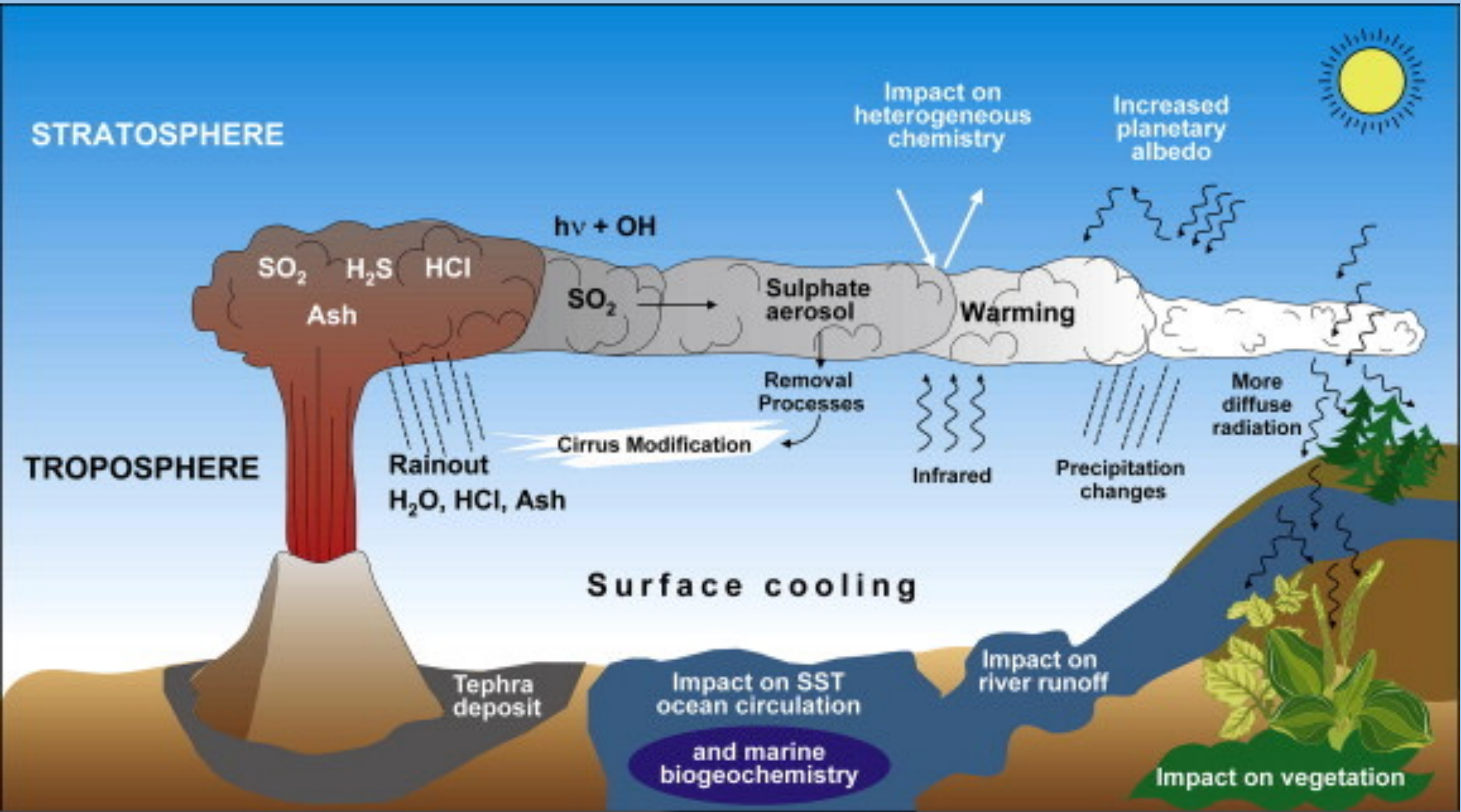

"Polar Vortex":
Cold air and low
pressure near the pole
Jet Stream
The jet stream
and cold air surge
south into the U.S.
Image: NOAA

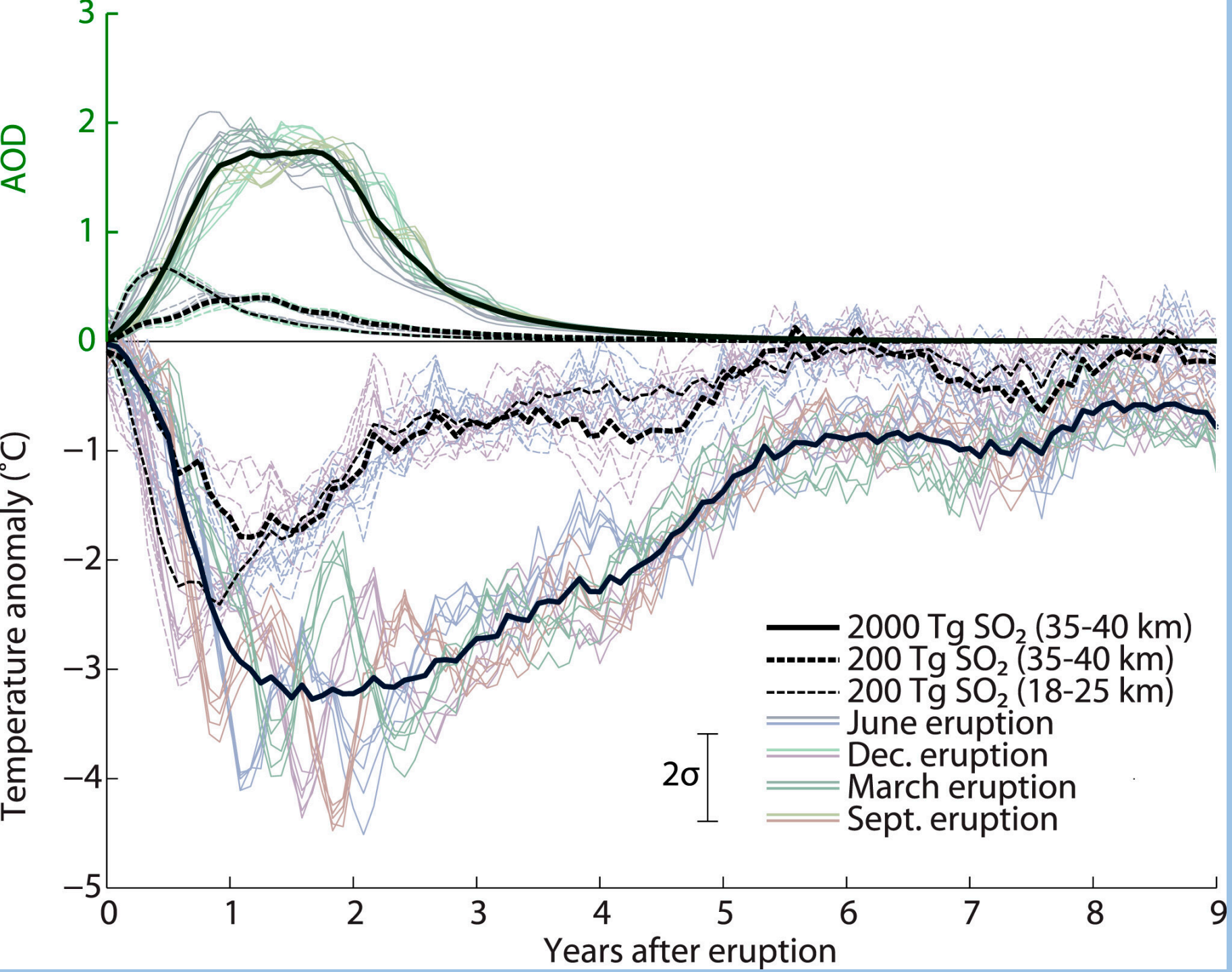
Volcanic Eruptions

- Sulphur = Usual, cooling

vs

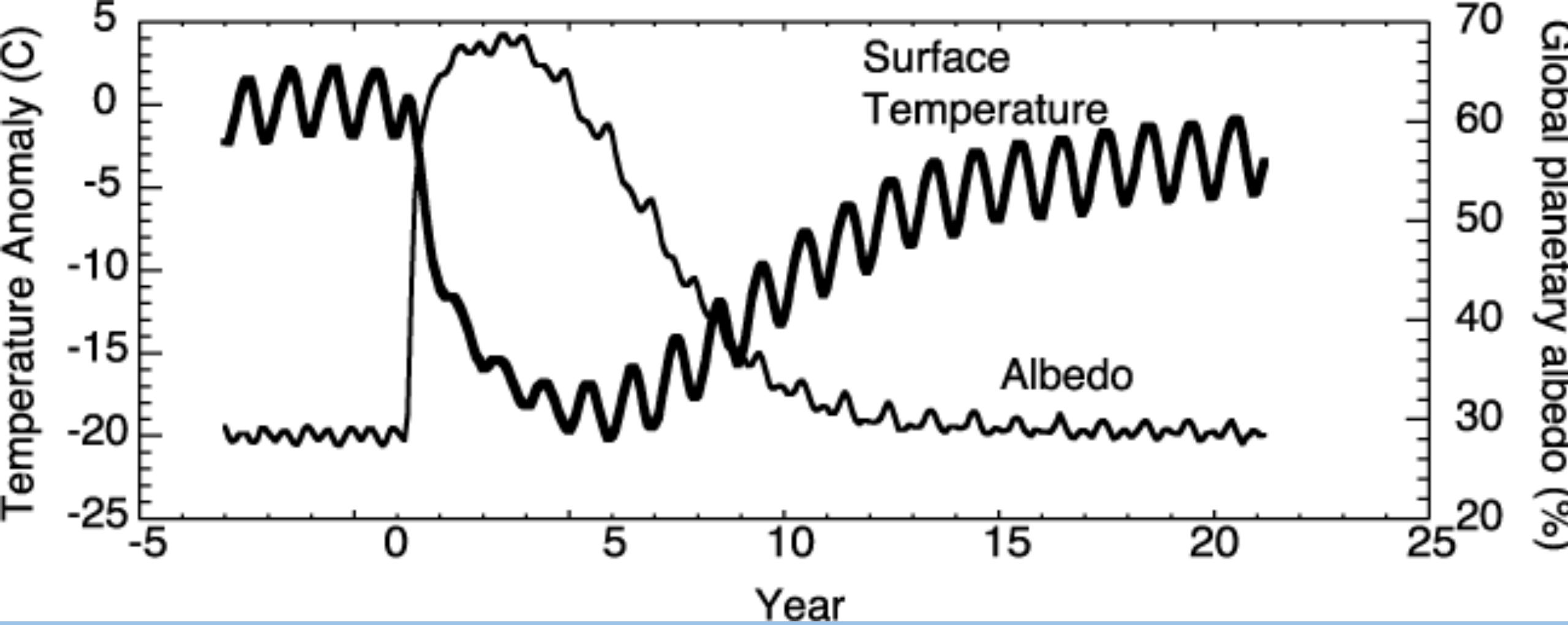
- Water = Rare, warming


STRATOSPHERE
TROPOSPHERE
Impact on heterogeneous chemistry
Increased planetary albedo
hν + OH
SO_2 H_2S HCl
Ash
SO_2
Sulphate aerosol
Warming
Removal Processes
Cirrus Modification
Rainout
H_2O, HCl, Ash
Infrared
Precipitation changes
More diffuse radiation
Surface cooling
Tephra deposit
Impact on SST ocean circulation
and marine biogeochemistry
Impact on river runoff
Impact on vegetation

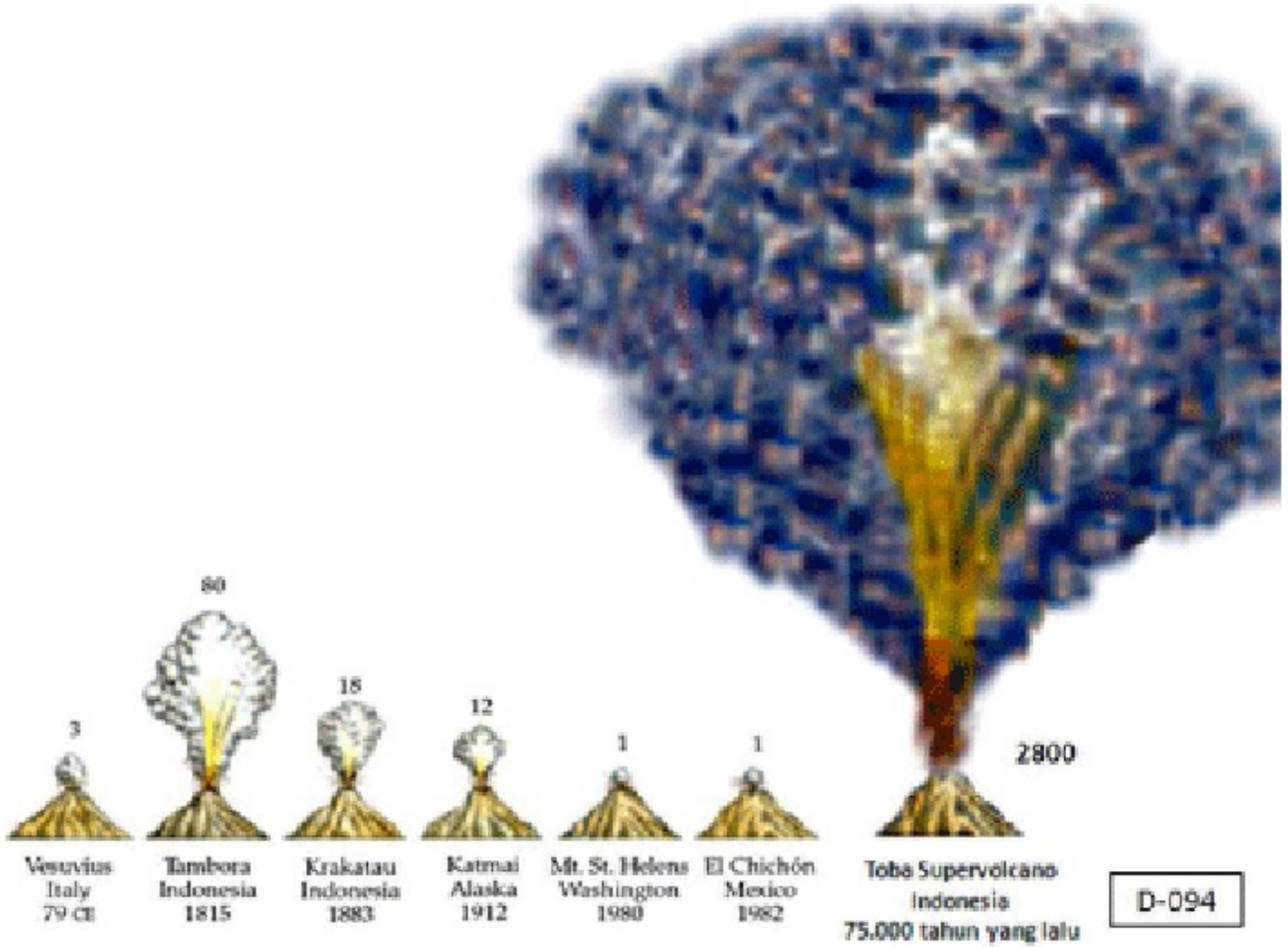


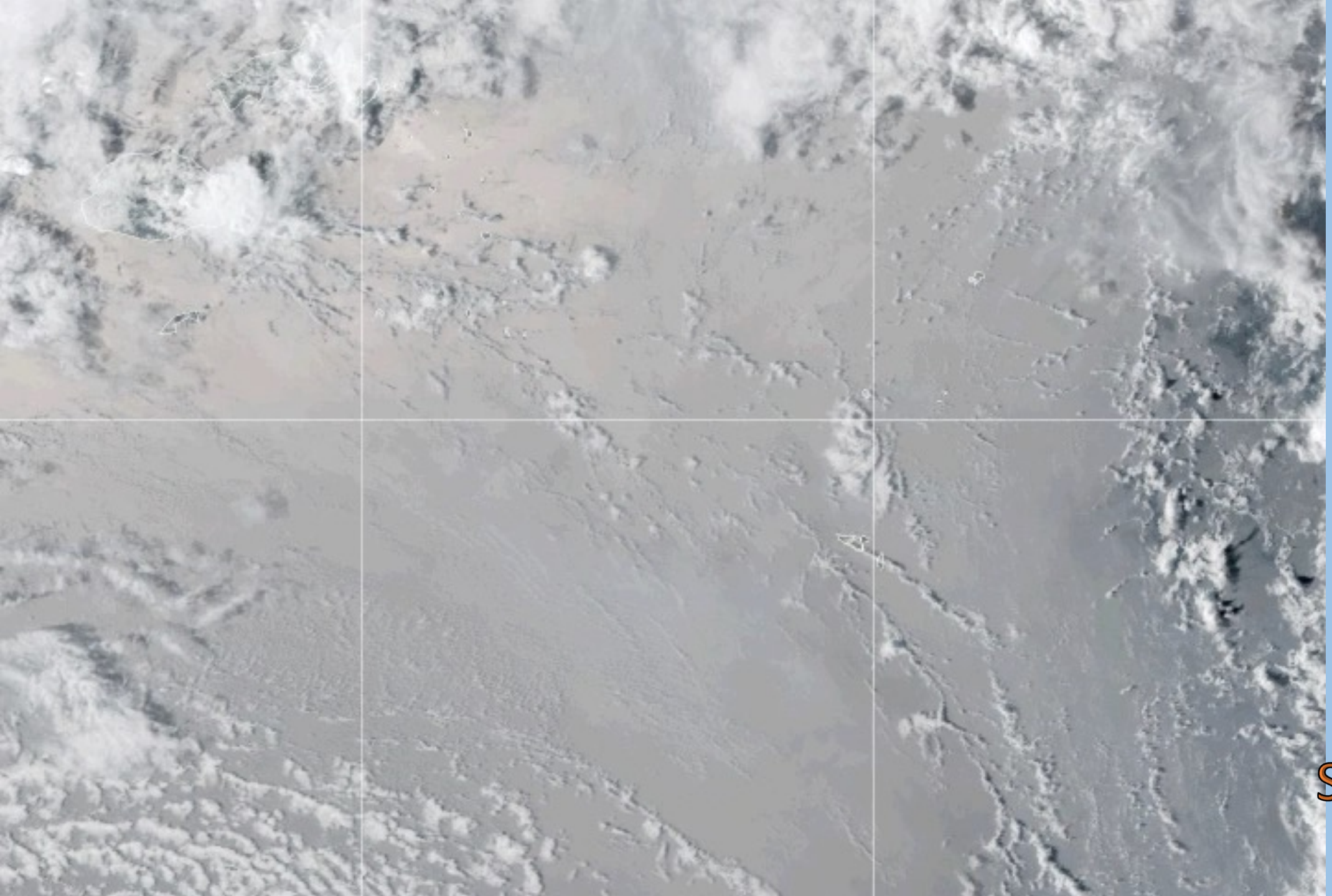
Climate forcing of Toba Eruption

Black, et al

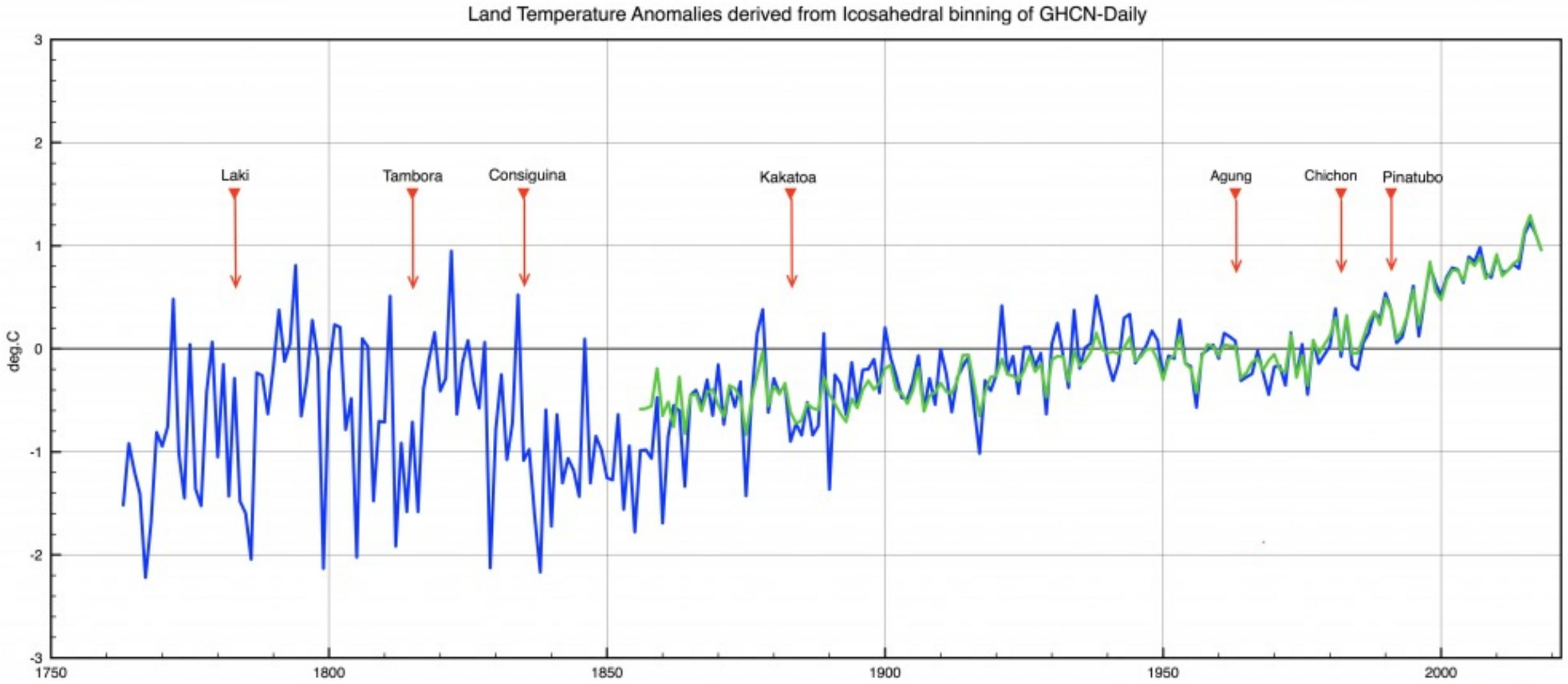


Climate forcing response from Toba Eruption
Typical of Sulphur dominated eruptions


3
80
18
12
1
1
2800
Vesuvius
Italy
79 CE
Tambora
Indonesia
1815
Krakatau
Indonesia
1883
Katmai
Alaska
1912
Mt. St. Helens
Washington
1980
El Chichón
Mexico
1982
Toba Supervolcano
Indonesia
75.000 tahun yang lalu
D-094



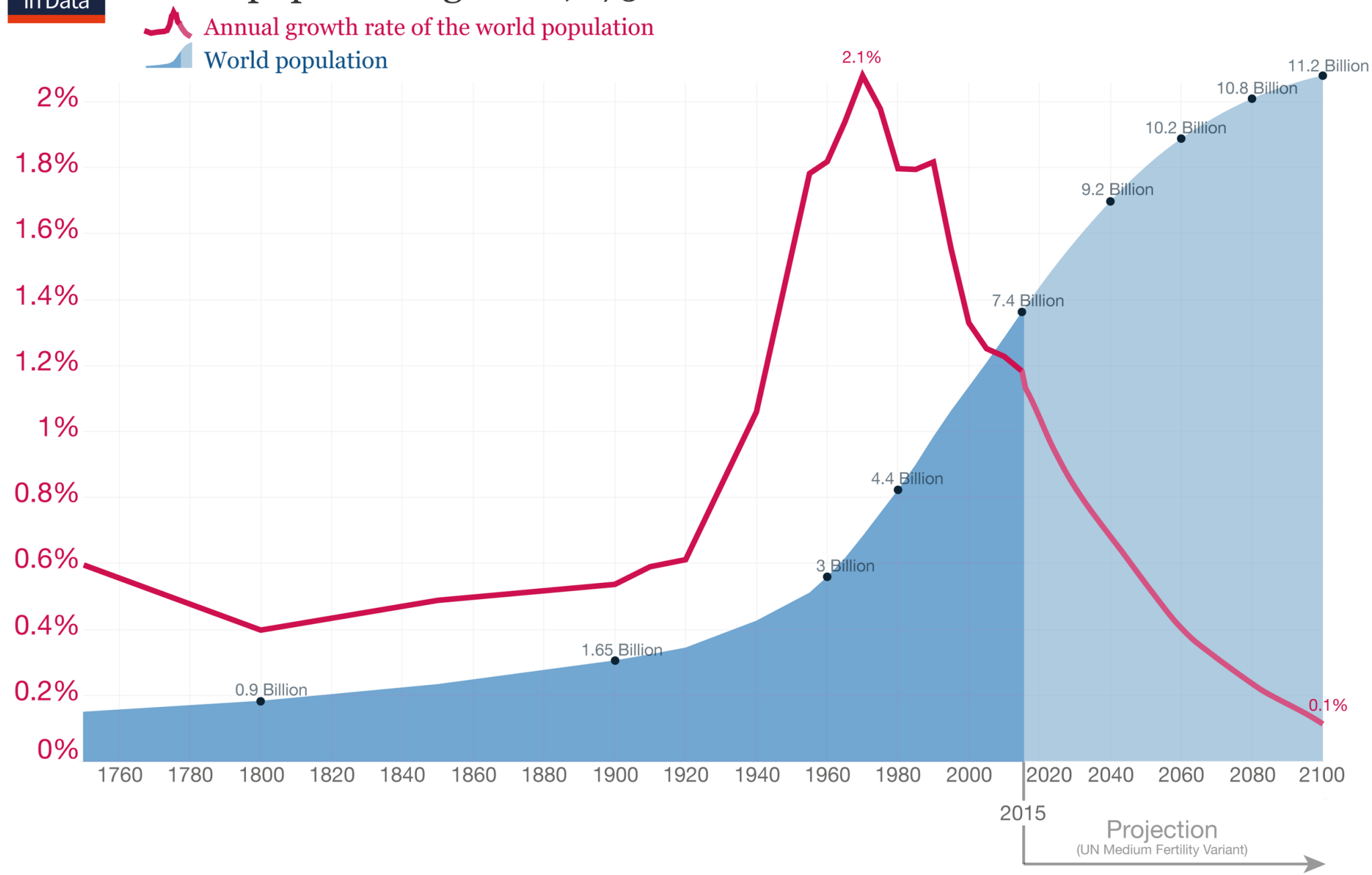
Tonga
Submerged
eruption



Volcanic climate forcing vs measured (post 1850) surface temperature anomalies (green)

Population Forcing

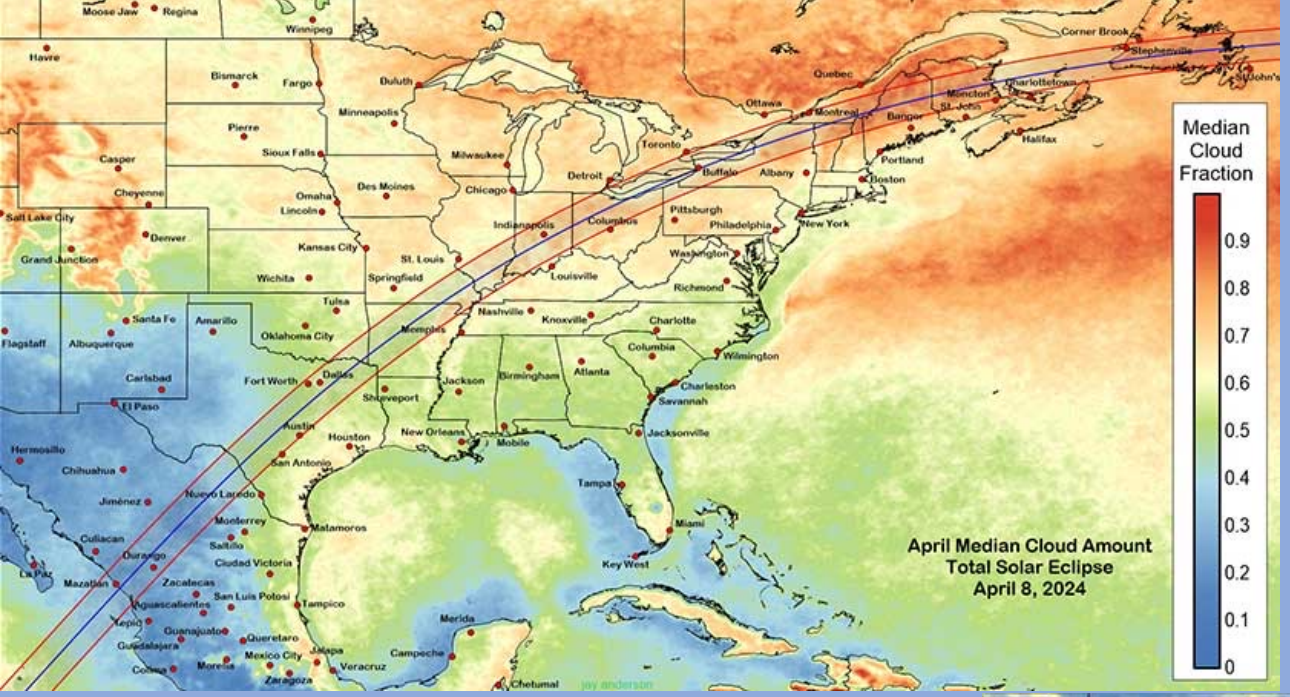
World population growth, 1750-2100



Data sources: Up to 2015 OurWorldInData series based on UN and HYDE. Projections for 2015 to 2100: UN Population Division (2015) – Medium Variant.
The data visualization is taken from OurWorldinData.org. There you find the raw data and more visualizations on this topic.

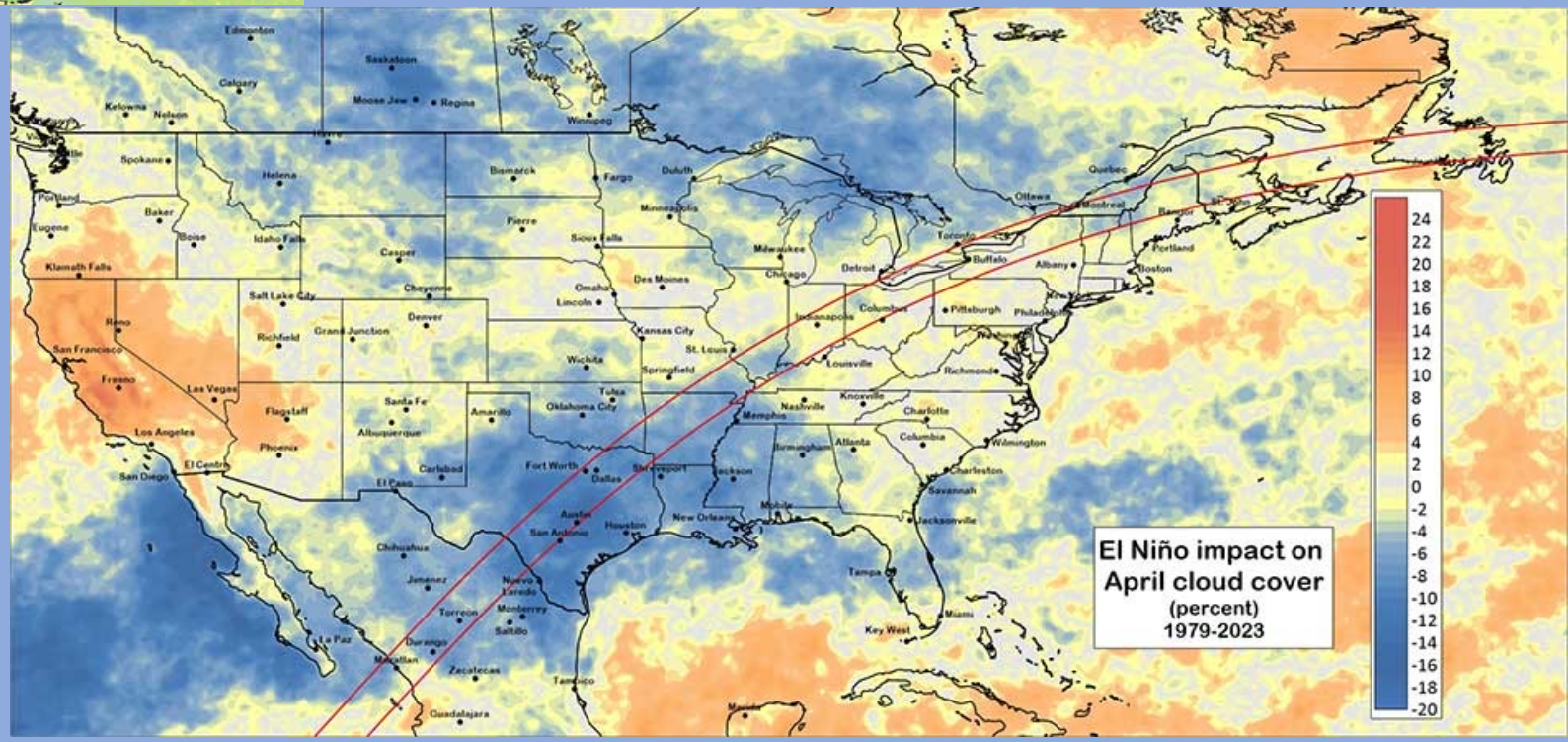
El Niño
And
La Niña
Effects

Second only to Seasonal Changes



Normal Cloud Cover

Predicted El Niño Forcing



Massive Methane Leaks
1200 Worldwide
2021-present


ICELAND
SWEDEN
NORWAY
RUSSIA
CANADA
UNITED KINGDOM
FRANCE
SPAIN
ITALY
TURKEY
KAZAKHSTAN
MONGOLIA
CHINA
JAPAN
MOROCCO
EGYPT
SAUDI ARABIA
PAKISTAN
INDIA
MYANMAR (BURMA)
MALI
SUDAN
YEMEN
ETHIOPIA
CAMEROON
KENYA
TANZANIA
ANGOLA
NAMIBIA
SOUTH AFRICA
MADAGASCAR
MALDIVES
MALAYSIA
INDONESIA
PHILIPPINES
PAPUA NEW GUINEA
AUSTRALIA
MEXICO
CUBA
COLOMBIA
PERU
BRAZIL
BOLIVIA
PARAGUAY