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Concept of the sky and stars navigation

Fa'atomoava'a Teri'iero'oitera'i

Francis Puara COWAN, the last Tahitian navigator



Heavenly bodies



Nearly 200 names of heavenly bodies were identified in the myths (stars, planets, constellations, nebulae ...)

For three purposes:

- **Marking of time (calendar ...)**
- **Location in space (navigation ...)**
- **Astrology, omens, oracles ...**

The variety of astronomical terms

North : *Apa-to'erau*

South: *Apa-to'a*

East : *Hiti'a, ni'a*

West : *Tō'o'a, raro*

Sun : *Rā*

Summer solstice : *Rua roa, rua maoro*

Winter solstice : *Rua poto*

Equinoxe (printemps/été) : *Matatau (roroa/poto)*

Equator : *Rāhiti*

Star : *Fetū*

Starpath (~latitude) : *Rua*

Star marker of starpath : *Ta'urua*

Celestial pillar (~longitude) : *Pou*

Star marker of celestial pillar : *'Ana*

Central celestial pillar (~Meridian) : *Pou nui*

North pillar (~North Pole) : *Pou fa'arava'aira'a*

Apogee (star at its highest point) : *Pōrouara'I*

Zenith : *Tānini upo'o*

Zenithal star : *'Avei'a*

Planet : *Fetūhoro*

Ecliptic : *Horo a Rā / Tuaourupo'i*

Comet : *Fetūave*

Shooting star : *Fetūrere*

Meteor : *Fetūpao / Pao*

Meteorite : *'Ōpūrei*

Constellation : *Hui fetū*

Stars compass : *Rua-fetū*

Winds compass : *Rua mata'i*

Horizon : *Paera'i*

Borders of "skies" on the horizon: *Hiti*

Nebulae : *Mahu*

Moon : *Marama*

(Lunar/Sun) eclipse : *Natua (marama / rā)*

Firmament / celestial vault : *'Apu o te ra'i*

Mythology



Ta'aroa (Tangaroa, Tangaloa, Kanaloa) comes out of his shell Rūmia in which he was confined for eternity, he created the universe, which inherits the sublime spherical shape of Rūmia

Mythology

The gods *Atea* the sky and *Papa* the earth remain clamped between the tentacles of the octopus *Tumura'i*, the *Po* "darkness" reigns in the world

To separate *Atea* and *Papa*, the god *Tāne* severed its tentacles and lifted the sky with 10 pillars (*Pou*)

The light invades the world, the stars were established in the sky in an order drawn up by *Tāne*, each was a divinity

Mythology

There are 10 "skies" (*ra'i*) stacked on each other as spilled bowls. Their borders, set on the ocean, constitute the 10 'borders' (*hiti*) succeeding on the horizon:

- *Ra'ituatahi* the "first sky" is the domain of human beings, where are the clouds, winds, oceans, land, sea and all living beings. The "skies" above are those domains of the gods.
- *Ra'ituarua* the "second sky" is that of *Marama*, "the Moon" so close, we hear *Hina* beating his *tapa* and we can see a banyan
- *Ra'ituatoru* the "third sky" is that of *Rā* "the Sun" and *horofetū* "planets".

Mythology



Then follow from bottom to top:

- ***Ra'ituahā*** the "fourth sky," the domain of larges stars called *ta'urua* and *'ana*
- ***Ra'ituarima, Ra'ituaono, Ra'ituafitu, Ra'ituavaru, Ra'ituaiva***, the "fifth, sixth, seventh, eighth and ninth sky", from bottom to top the rest of the stars, from the largest to the smallest
- ***Ra'ituatini*** the "tenth sky" contains the tiny stars of the Milky Way (*Vaiora*), inhabited by the god *Tāne*, his shark *Fa'arava-i-te-ra'i* "Altair" and his bird *Pira'etea* "Deneb "



HITI : borders « skies » on the horizon

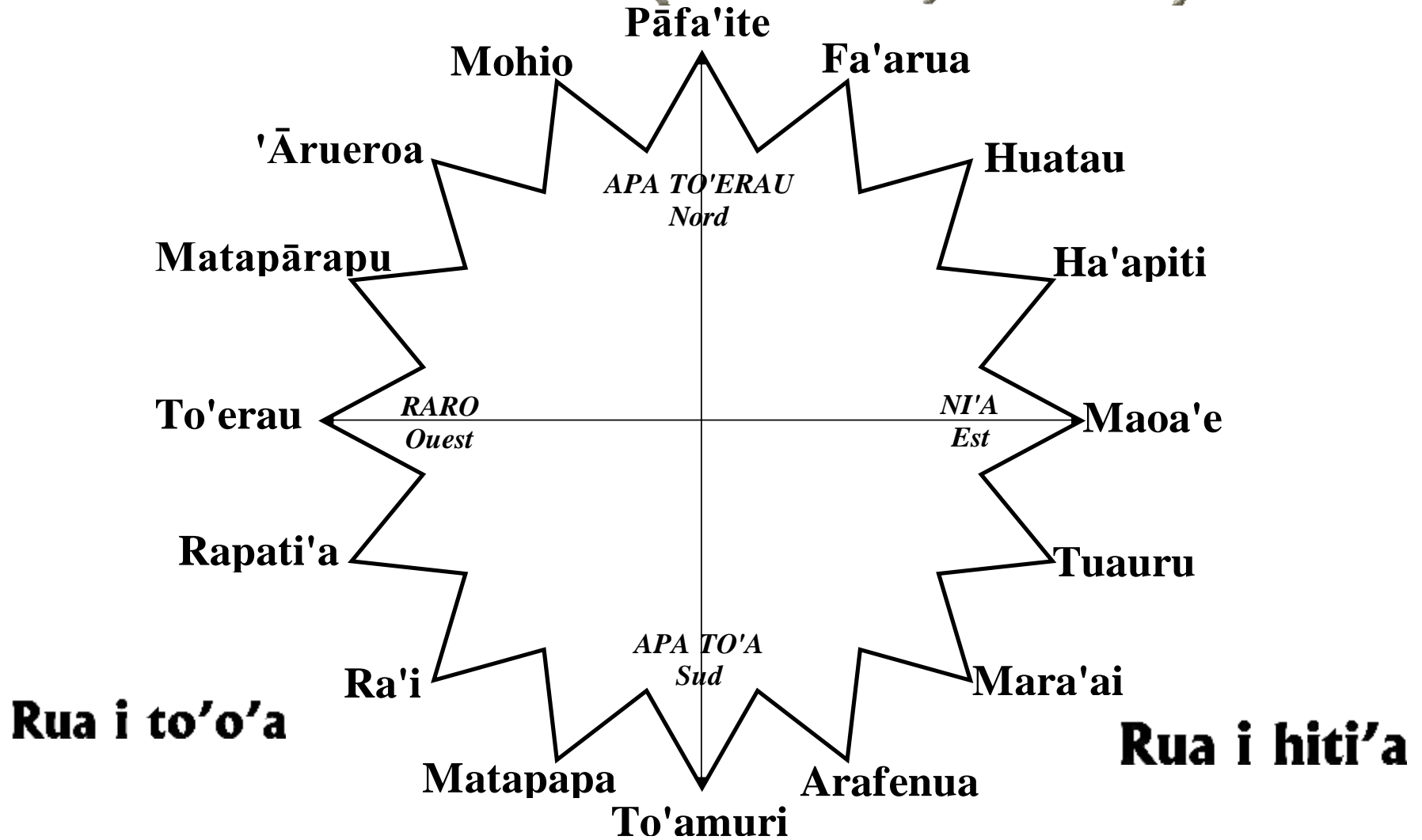
- **Heroes can sail at the horizon to the borders of the first nine "skies" (*hiti*).**
- **At the border of the tenth (*Hiti tiri-tai*), the waters of the ocean fall into the abyss (*rua*) from which emerge the winds and the stars**

Vision of heaven

Rua mata'i : winds compass

- Every wind that emerges from a *rua* at the horizon has a name according to its azimuth: *To'erau, Mara'ai, Maa'e, Fa'arua ...*
- These winds are the compass called *rua mata'i*

Rua mata'i (Puhoro, 1774)

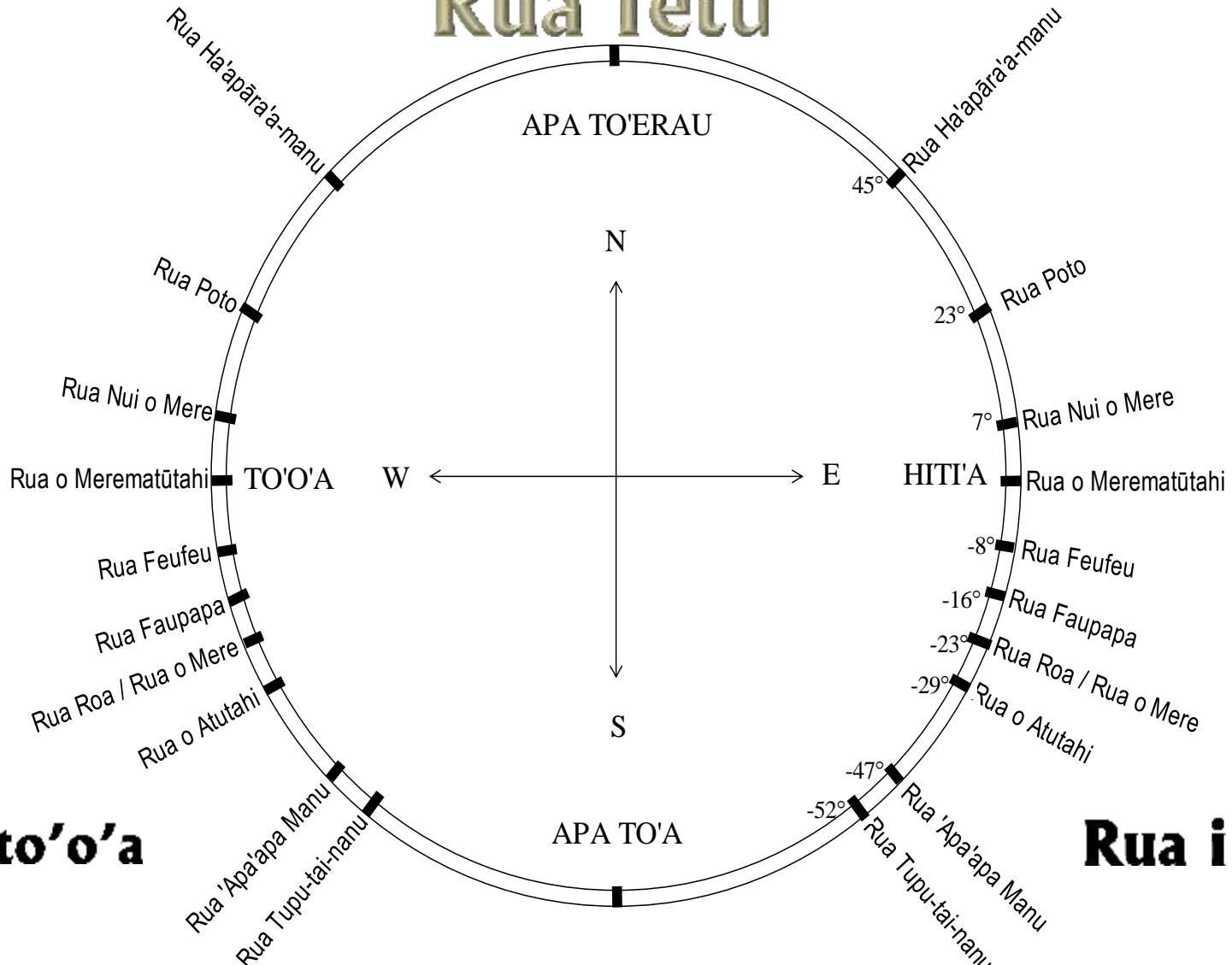


Vision of heaven

Rua fetū : stars compass

- Each series of aligned stars that emerge from the horizon to the east is called *rua*.
- There are ten identified by their azimuth: *rua faupapa*, *rua o Mere*, *rua manu*, etc.
- They form the star compass called *rua fetū*.
- These *rua fetū* then run through the heavenly vault keeping their figure aligned and plotting kinds of paths in the sky before sinking to the West.

Rua fetū



Vision of heaven

Pou : celestial pillar

- **Ten stars of the first magnitude help to identify a “celestial pillar” when they are at their peak.**
- **They are about ten who succeeds, in turn, to the climax of heaven.**
- **Aligned at their peak with another star located around the celestial poles (Dubhe), each of which in turn, determines a celestial pillar coinciding with the celestial meridian.**

Planet : *Fetūhoro*

5 planets :

Venus : *Ta'urua-horopo'ipo'i / Ta'urua-horoahiahi*

Jupiter : *Ta'urua-horopo'ipo'i / Ta'urua-horoahiahi*

Mars : *Maunu'ura / Fetū'ura*

Mercury : *Ta'ero*

Saturn : *Fetūtea*

You are here

Star : *fetū*

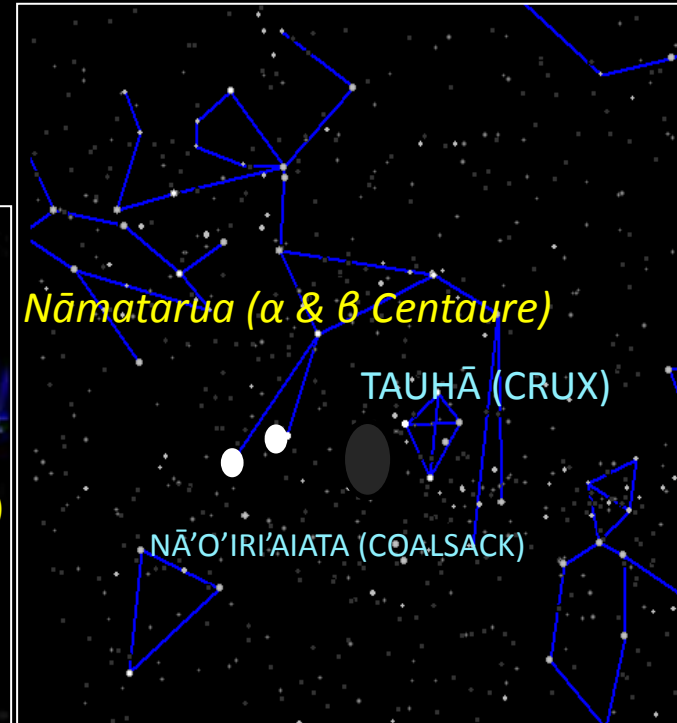
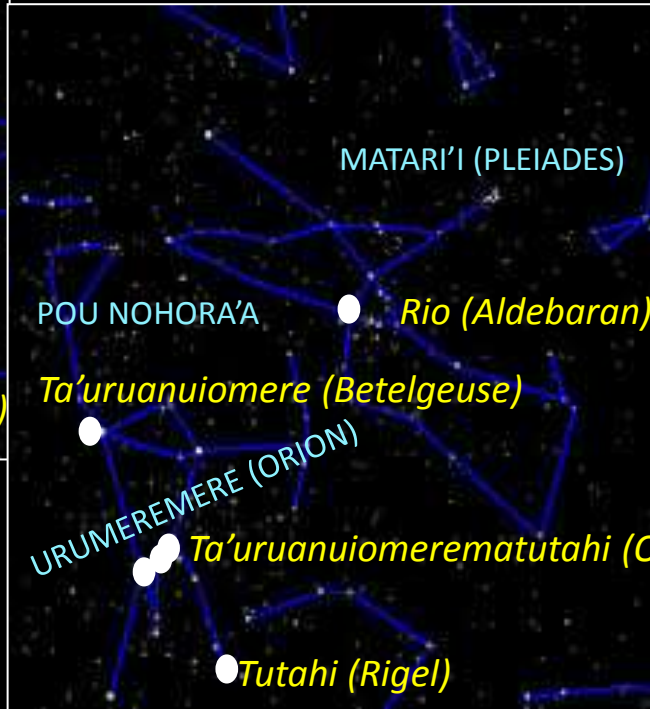
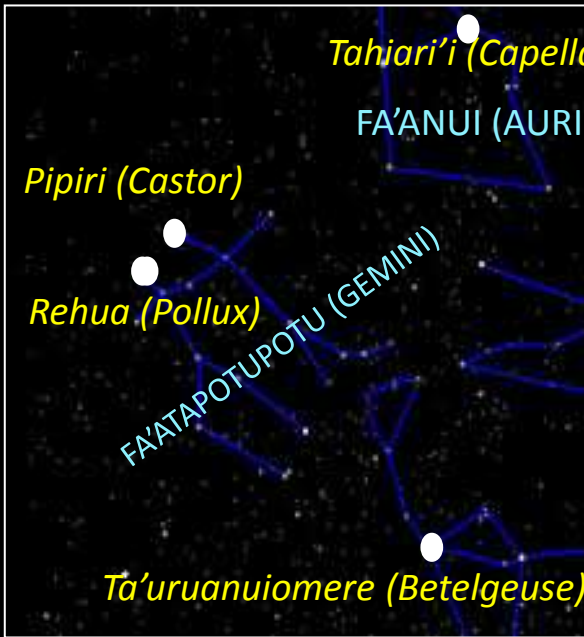
The stars are divided into 3 classes:

- *'Avei'a* "guide star" that which passes through the zenith of an island and allows to identify it
- *'Ana* "star marker" is one that, at its peak, can identify a pillar (*Pou*)
- *Taurua* "star headlight" that which, on the horizon, can identify a starpath (*Rua*)

Names of some stars

- **Tahiari'i : Capella**
- **Rio : Aldebaran**
- **Mariua : Spica**
- **Fa'aravaitera'i : Altair**
- **Pira'etea : Deneb**
- **Ari'iomara'ire'a : Vega**
- **Ari'io'apato'a : Achernar**
- **Pīpiri : Castor**
- **Rehua : Pollux**
- **Tūtahi : Rigel**
- **Hotuitera'i : Antares**
- **'Anani'a : Polaris**
- **'Anatahu'ata'ata : Arcturus**
- **Ta'urua-faupapa : Sirius**

Some stars : *fetū*



Grouping the stars :

hui fetū, hui tārava, pou, rua

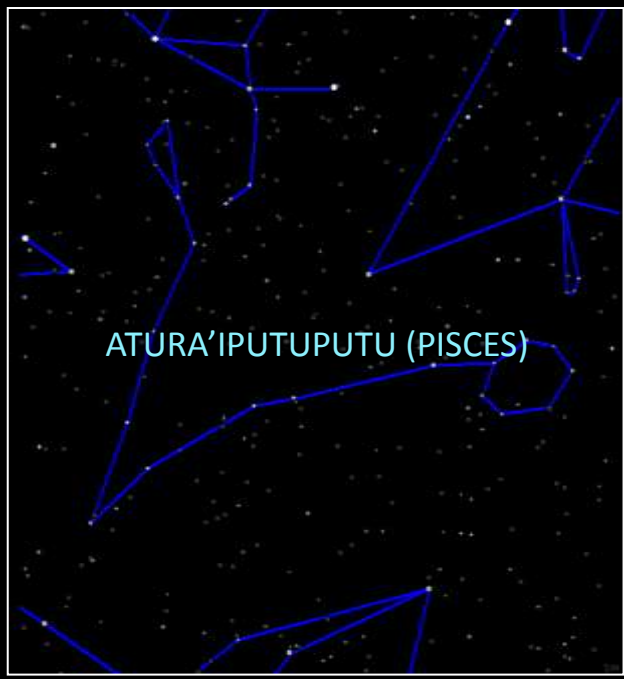
Stars can be :

- grouped according to a figure, as in the Western constellations : *Hui-fetū* or *Hui-tārava*
- aligned according to a star path : *Pou* (celestial pillar) and *Rua* (celestial path)

Some constellations : *hui fetū, hui tārava*


- ***Matau a Tafa'i* : Scorpion**
- ***Nāmatarua* : α & β du Centaure**
- ***Matari'i* : les Pleiades**
- ***Moana'ohunoa'eiha'amoehara* : Crater**
- ***Pīpirimā, Nā'ainanu* : Castor & Pollux**
- ***Fa'atāpotupotu* : Gemini**
- ***Tautoru, Mere* : Orion's belt**
- ***Urumeremere* : Orion**
- ***Tauhā* : Crux**
- ***Atutahi* : Pisce Austrinus**
- ***Atura'iputuputu* : Pisces**
- ***Fa'aiti* : Perseus**
- ***Ma'ama'atai* : Corvus**
- ***Tūitemoanaurifa* : Hydra**

Constellations : *hui fetū, hui tārava*



ATURA'IPUTUPUTU (PISCES)

A star chart of the constellation Atura'iputuputu (Pisces) on a black background. The stars are connected by blue lines to form the constellation's shape. The chart is enclosed in a white rectangular border.



FA'AITI (PERSEUS)

A star chart of the constellation Fa'aiti (Perseus) on a black background. The stars are connected by blue lines to form the constellation's shape. The chart is enclosed in a white rectangular border.



MA'AMA'ATAI (CORVUS)

A star chart of the constellation Ma'ama'atai (Corvus) on a black background. The stars are connected by blue lines to form the constellation's shape. The chart is enclosed in a white rectangular border.

TŪITEMOANAU RIFĀ (HYDRA)

Pou « pillar » & '*Ana* « pointer star »

The 10 *Pou* pillars identified by their respective '*Ana* "pointer stars":

- 1) ***POU MUA* ('*Anamua*) : SCORPIO (Antares)**
- 2) ***POU MURI* ('*Anamuri*) : LIBRA (Zuben-Eschamali)**
- 3) ***POU ROTO* ('*Anaroto*) : LEO (Regulus)**
- 4) ***POU TIA'I* ('*Anatīpū*) : URSA MAJOR (Dubhe)**
- 5) ***POU 'ŌRERORERORA'A* ('*Anaheuheupō*) : HYDRA (Alphard)**
- 6) ***POU VĀNA'ANA'ARA'A* ('*Ana-tahu'a-ta'ata-metua*) : BOOTES (Arcturus)**
- 7) ***POU-TI'ARA'A* ('*Ana-tahu'a-vahine*): CANIS MINOR (Procyon)**
- 8) ***POU NOHORA'A* ('*Anavaru*) : ORION (Betelgeuse)**
- 9) ***POU HAERERA'A* ('*Anaiva*) : COLUMBA (Phact)**
- 10) ***POU FA'ARAVA'AIRAA* ('*Anani'a*) : URSA MINOR (Polaris)**

Pou & 'Ana

'Anamuri (Zubeneschamali)

POU MURI (LIBRA)
'UO (SCORPIO-NORTH)

'Anamua (Antares)

POU MUA

MATAU' NUI (SCORPION-SOUTH)

'Anatipu (Dubhe)

POU TIA'I (URSA MAJOR)

'Anatahu'avahine (Procyon)

POU VĀNA'ANA'ARA'A (CANIS MINOR)

FA'ATAPOTUPOTU (GEMINI)

RUA « Starpath » et *TA'URUA*, « pointer star »

The 10 *Rua* identified by their respective *Ta'urua* “pointer stars”:

1. *RUA I-TE-HA'APARA'A-MANU* (*Ta'urua-i-te-ha'apara'a-manu*) : **CYGNUS** (Deneb)
2. *RUA NUI O MERE* (*Ta'urua-nui-o-mere*) : **ORION-NORTH** (Betelgeuse)
3. *RUA O MERE-MA-TŪTAHI* (*Ta'urua-o-mere-ma-Tūtahi*) : **ORION'S BELT** (3 stars)
4. *RUA FEUFEU* (*Ta'urua-feufeu*) : **HYDRA-NORTH** (Alphard)
5. *RUA FAUPAPA* (*Ta'urua-faupapa*) : **CANS MINOR** (Sirius)
6. *RUA O ATUTAHI* (*Ta'urua-nui-o-Atutahi*) : **PISCE AUSTRINUS** (Fomalhaut)
7. *RUA O MERE* (*Ta'urua-o-mere*) : **CAPRICORN** (Deneb Algedi) [**RUA ROA** : Summer solstice]
8. *RUA MANU* (*Ta'urua-manu*) : **GRUS** (Alnair)
9. *RUA-TUPU-TAI-NANU* (*Ta'urua-tupu-tai-nanu*) : **ARGO** (Canopus)
10. *RUA POTO* (*Rā*) : **Sun** at winter solstice

Two planets, *Ta'urua-nui-horo-po'ipo'i* / *Ta'urua-nui-horo-ahiahi* (Jupiter / Venus), indicate the path traced by the planets, the ecliptic.

Rua & Ta'urua

Ta'uruānuiomere (Bételgeuse)

Ta'uruaoomerematūtahi (Ceinture d'Orion)

RUA O MEREMATUTAHĪ (CEINTURE D'ORION)

Tutahi (Rigel)

Ta'uruafaupapa (Sirius)

RUA FAUPAPA (GRAND CHIEN)

'Anaiva (Phaet)

POU HAERERĀ'A (COLOMBE)

Ta'uruaoatutahi (Fomalhaut)

RUA O ATUTAHĪ (POISSON AUSTRAL)

Ta'uruamanu (Alnair)

RUA MANU (GRUE)

Ta'uruaitēha'apara'amanu

Pira'etea (Deneb)

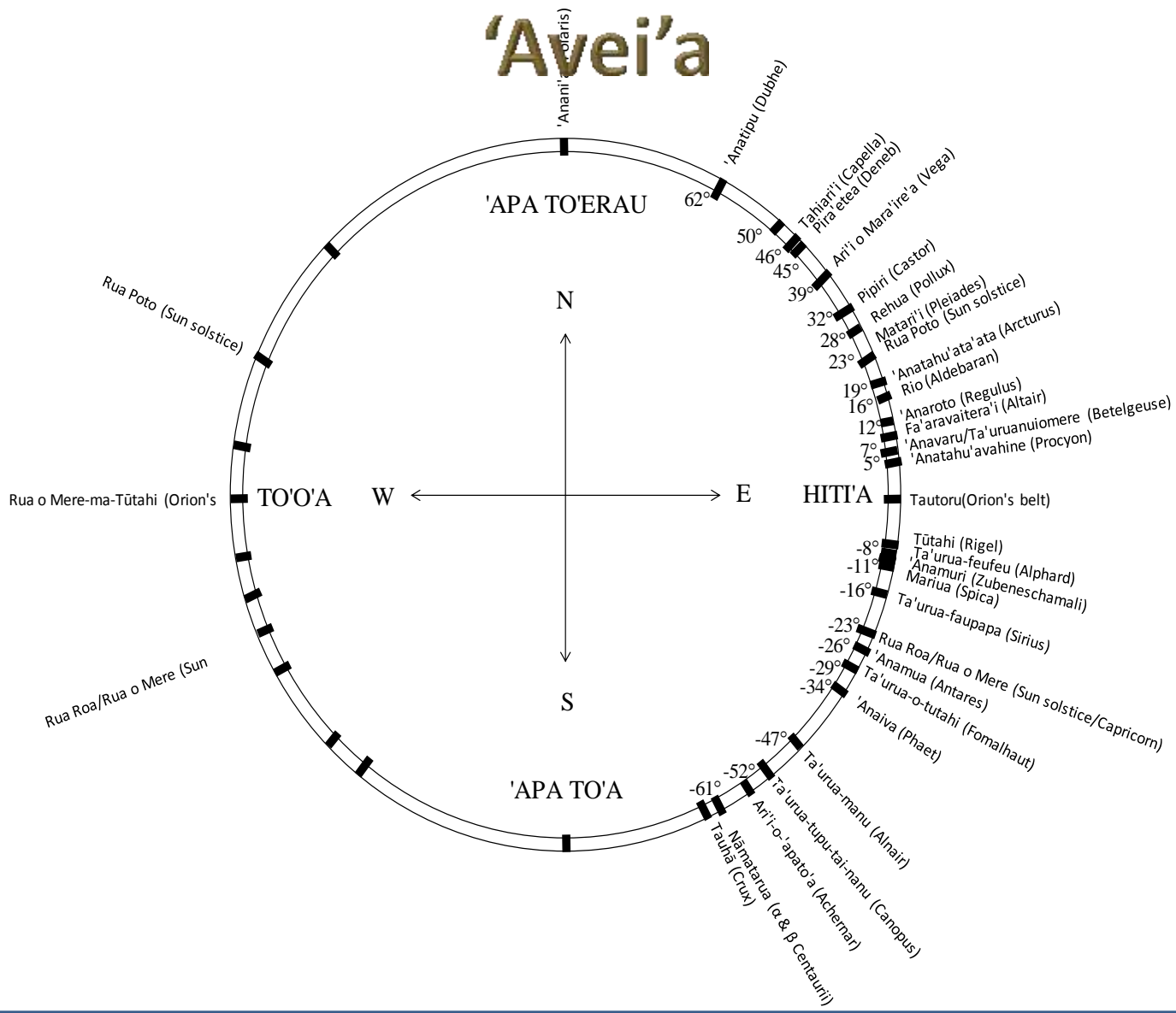
RUA-HA'APARA'AMANU (CYGNE)

Ar'iomara'ire'a (Vega)

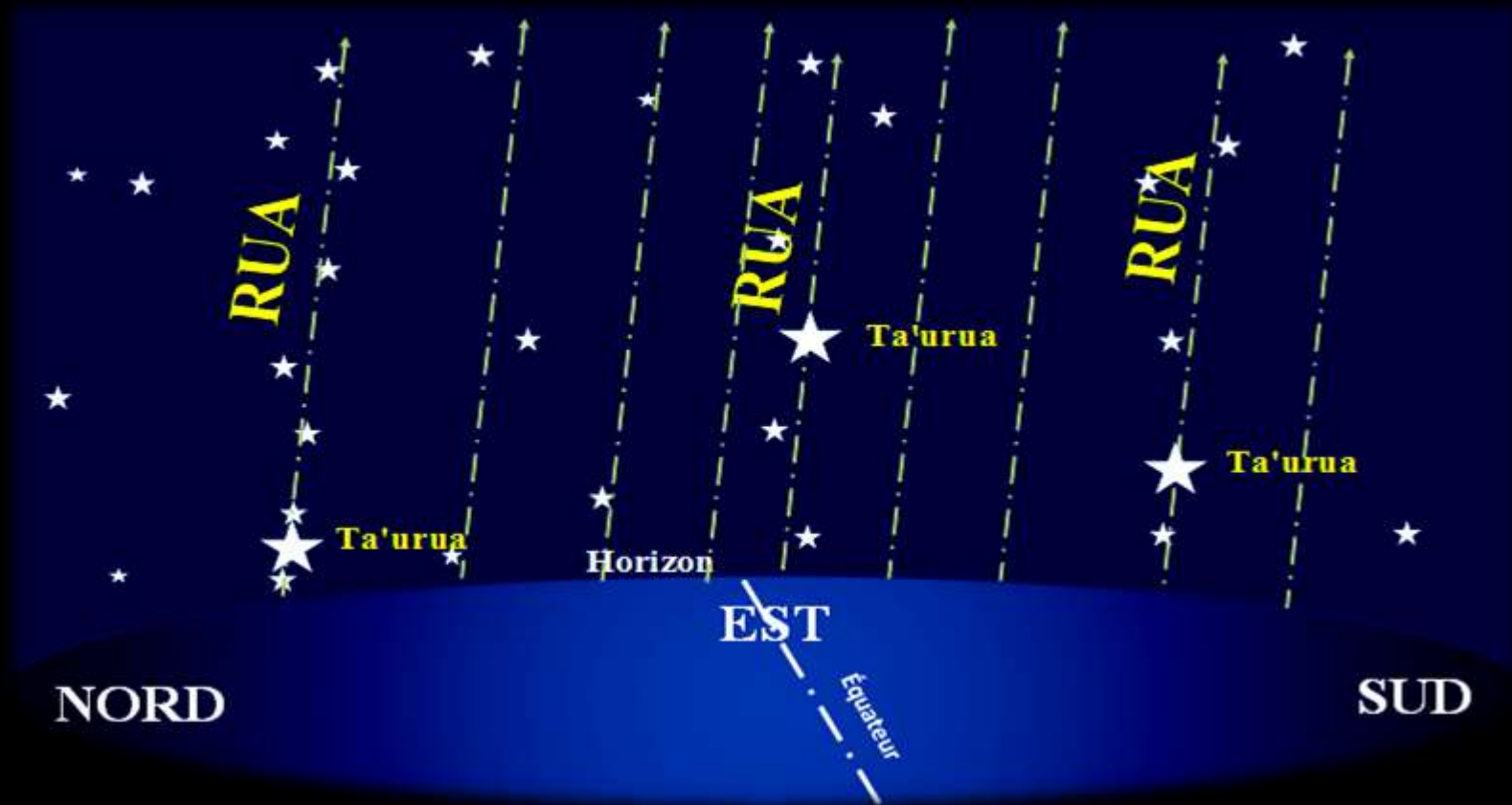
Zenithal Star : 'avei'a

- **Every island is identified by its 'avei'a his zenith star. All Star can be an 'avei'a including star classed 'Ana & Ta'urua**
- **Every star is the reflection on the heavenly vault of an island, as a result, the heavenly vault reflects the inverted map of the world**

'Avei'a

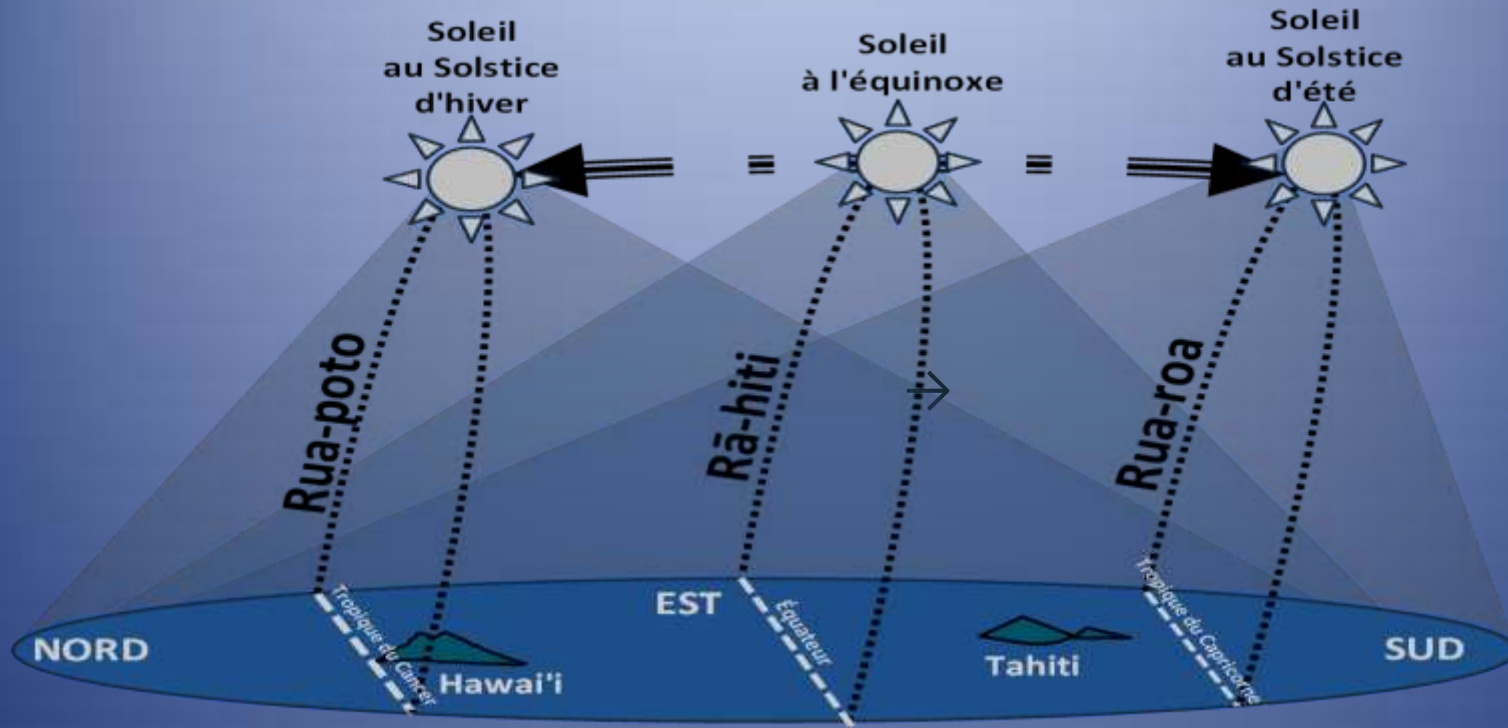


Rua fetū « Starpath »



If we sail north to south, we cross one after another all *Rua*

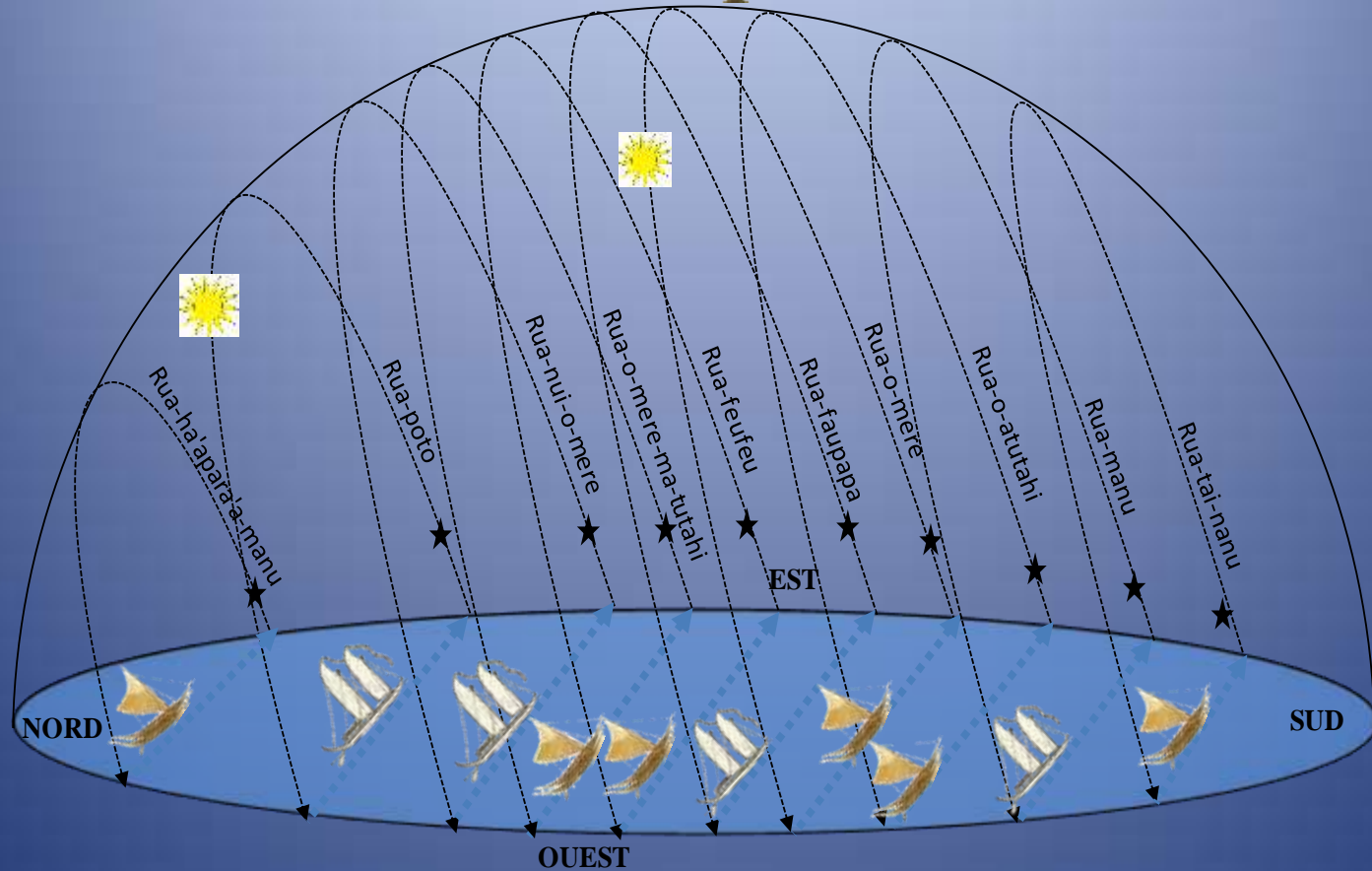
RUA POTO, RUA ROA : The paths of the sun



In one year, the point on the horizon where the sun rises or sets moves:

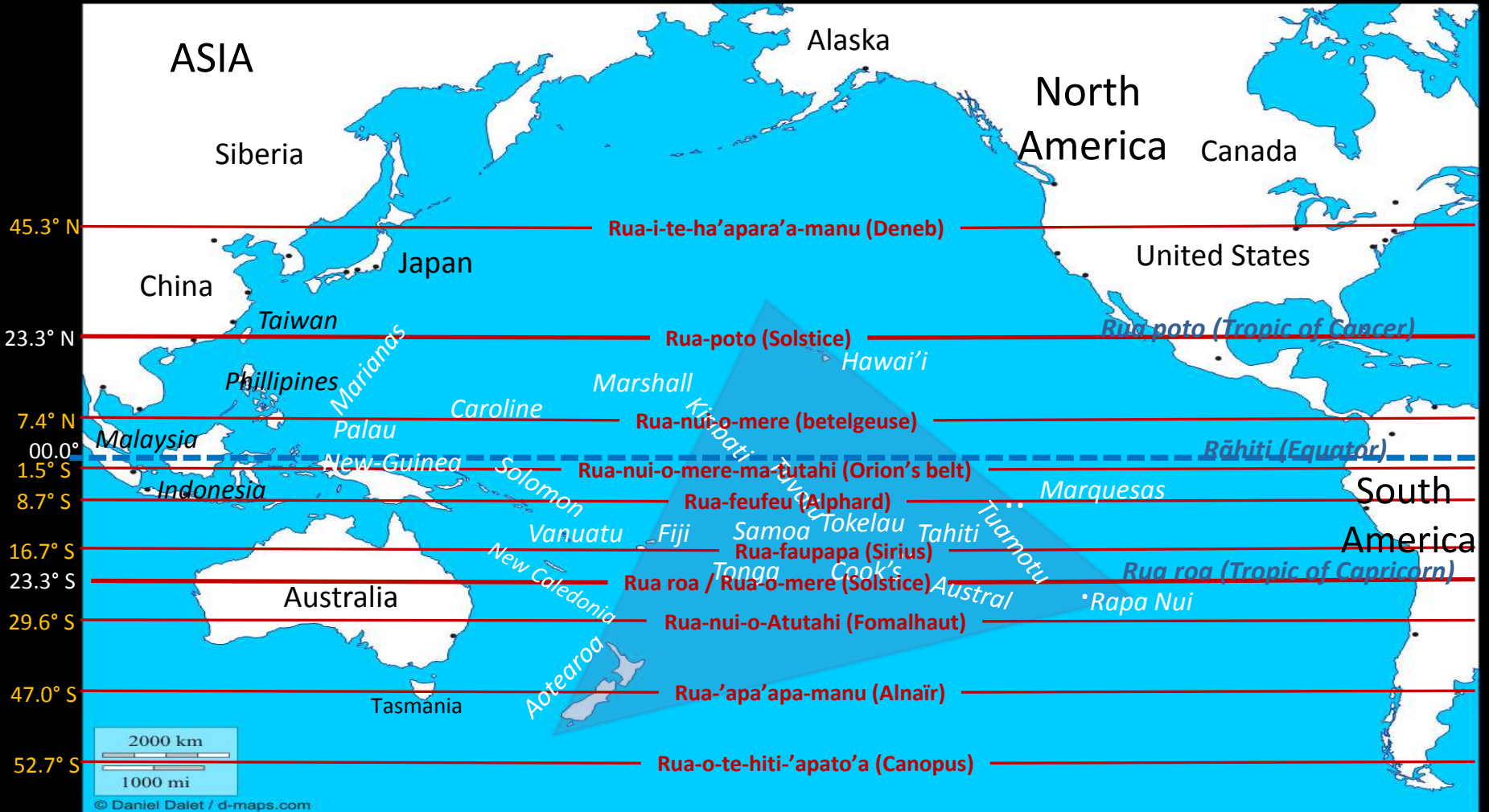
- At the winter solstice (June 21 ~), it is further north, to the Tropic of Cancer: *Rua poto*
- At the summer solstice (~ December 21), it is further south to the Tropic of Capricorn: *Rua roa*

RUA « as parallel »



➤ Every *rua* draws a line on the vault assimilated in modern geography to a parallel. In navigation Tahitians used 10 *rua*

Plotting of *rua* over the Pacific



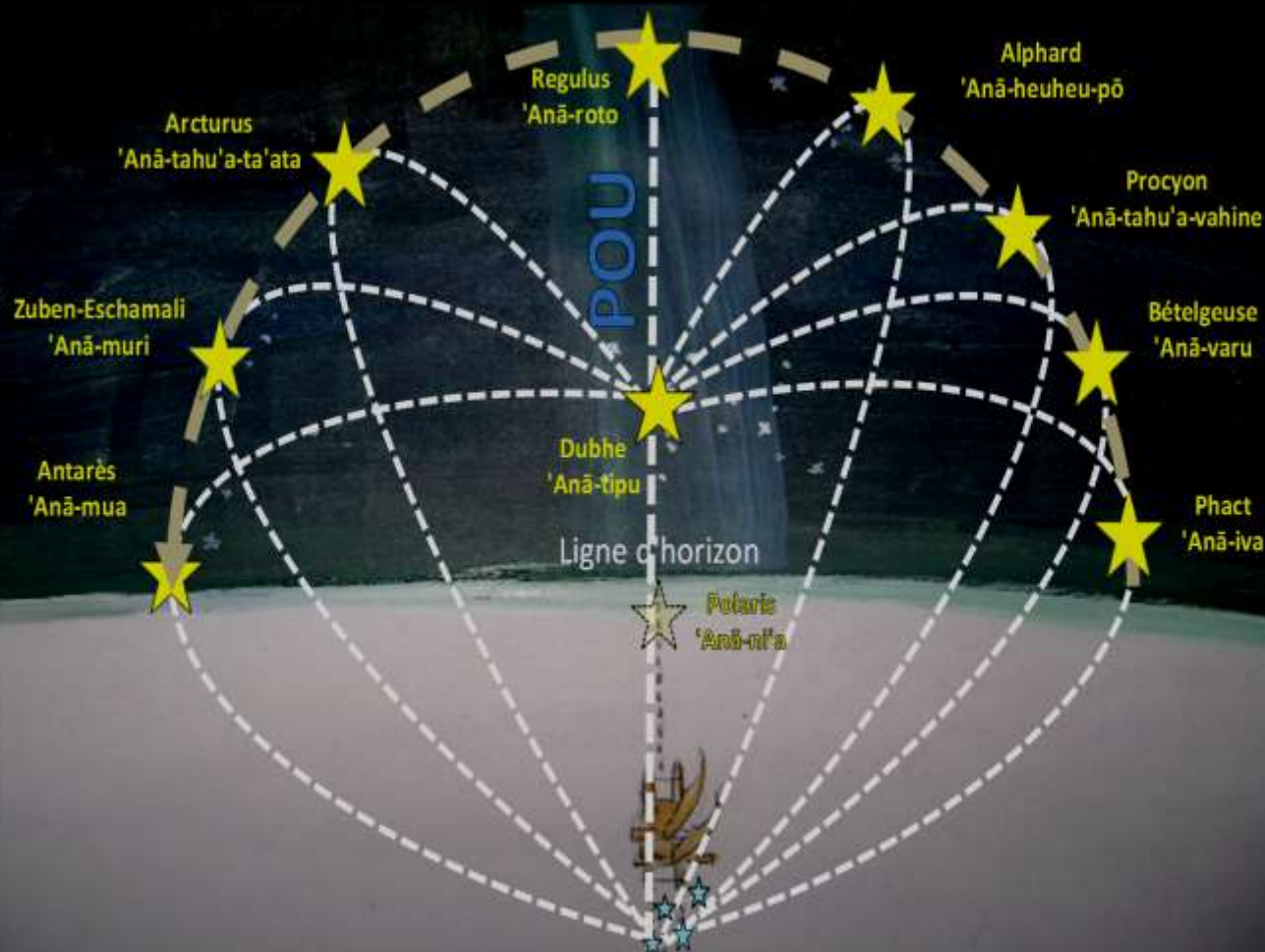
NAVIGATING BY USING A *RUA*



➤ To navigate using a *rua*, you must align the body of your canoe on the axis of the *rua*

➤ Even when tacking, it is possible to insure your trajectory, returning at every moment on the axis the star did with the body of the canoe

POU « as méridian »

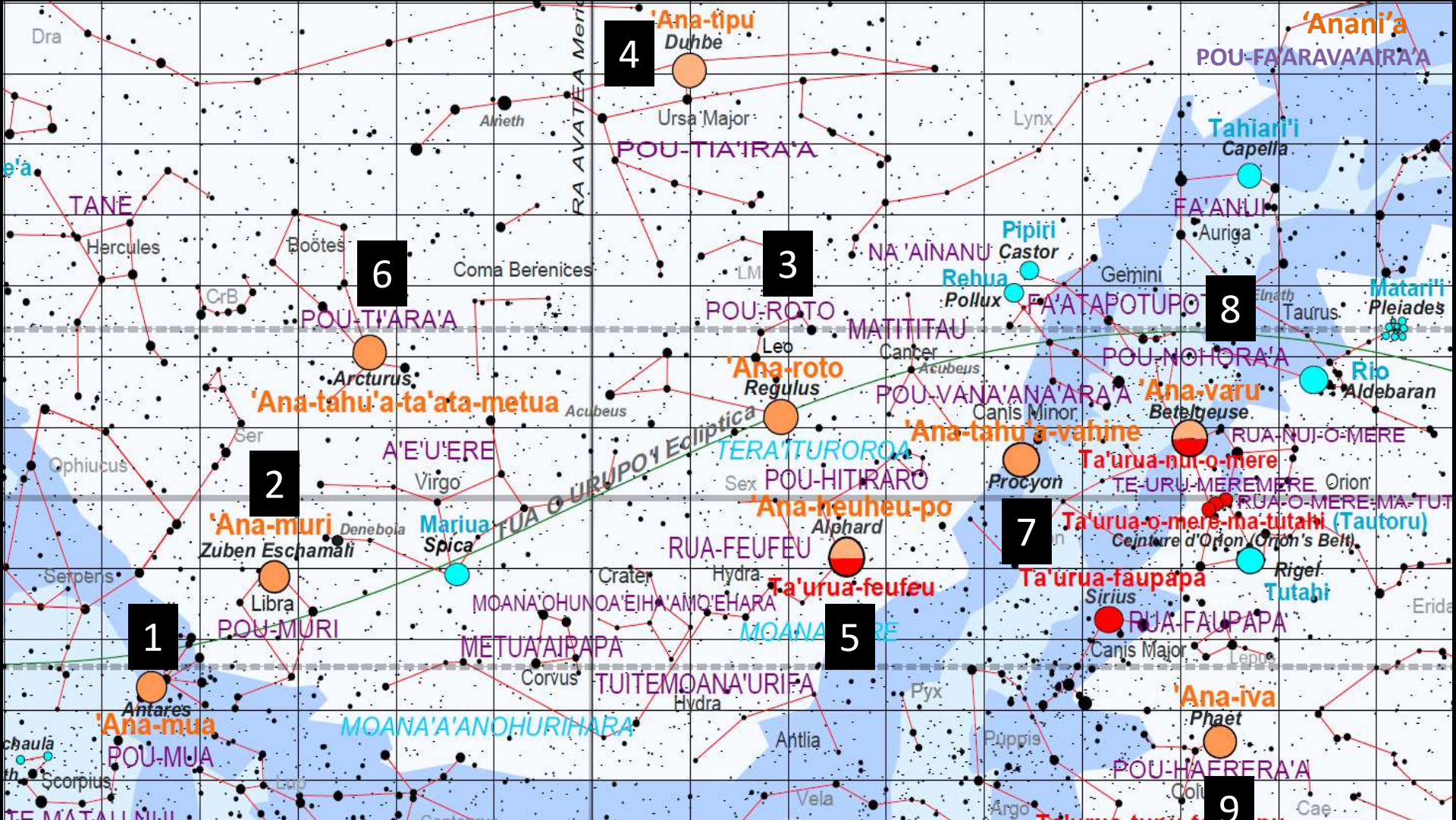


➤ The sky dome is crossed by 10 'Ana stars succeeding to the climax

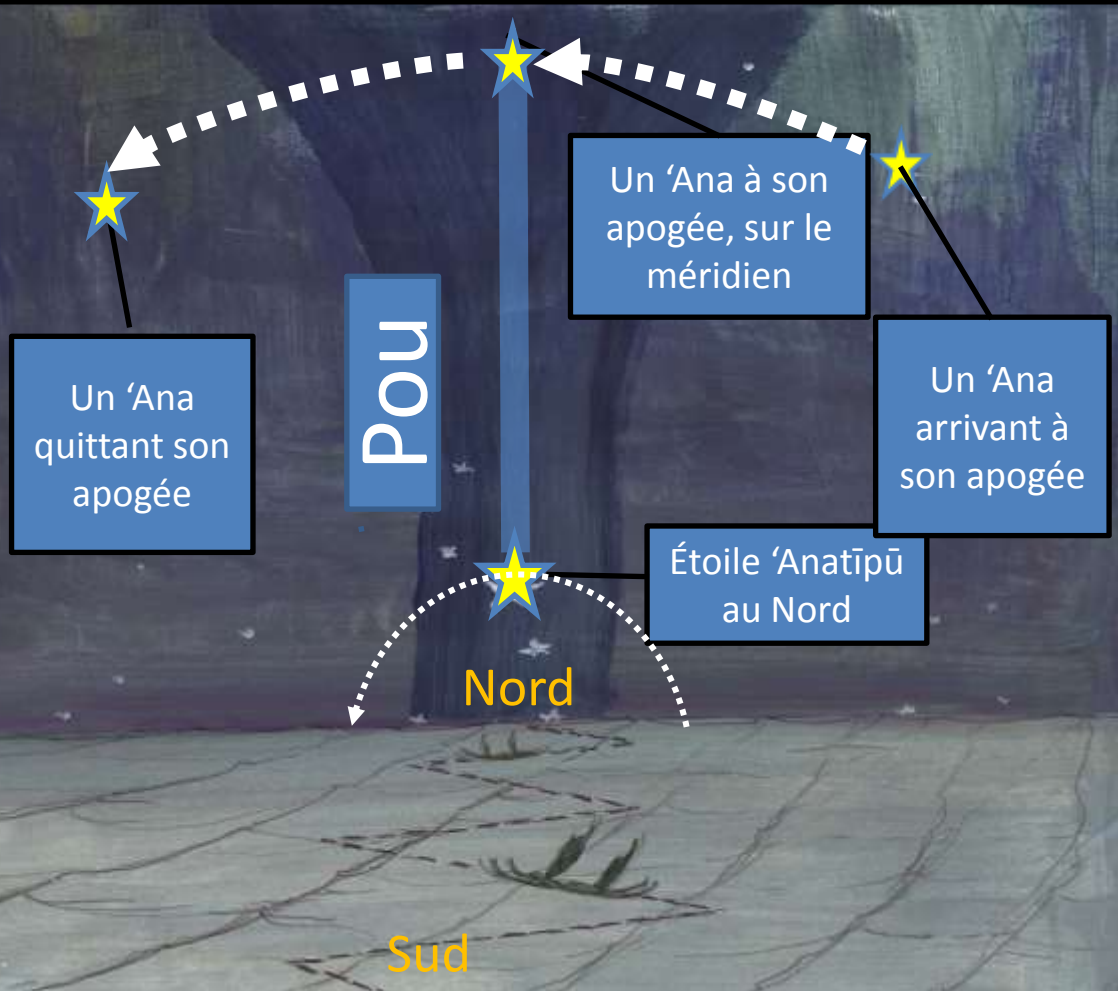
➤ The line joining one of them, located at its peak, to the star 'Anatīpū (Dubhe) located to the north, is similar to the meridian

➤ There are enough 'Ana order to view a meridian all night

10 Pillars « Pou »



NAVIGATING BY USING A « POU »



- In the southern hemisphere, to navigate from South to North, we must align the body of our canoe on the axis formed by a star 'Ana at its peak with 'Anatīpū (Duhbe) located in the North
- As soon as the star leaves his heyday, choose the following coming from the east
- In the northern hemisphere: choose 'Anani'a (Polaris) instead of Anatīpū

Definition : RUA & POU

Anatīpū

North Pole

A RUA is a series of stars aligned from east to west identified by its major star called *Ta'urua*



'Ana...

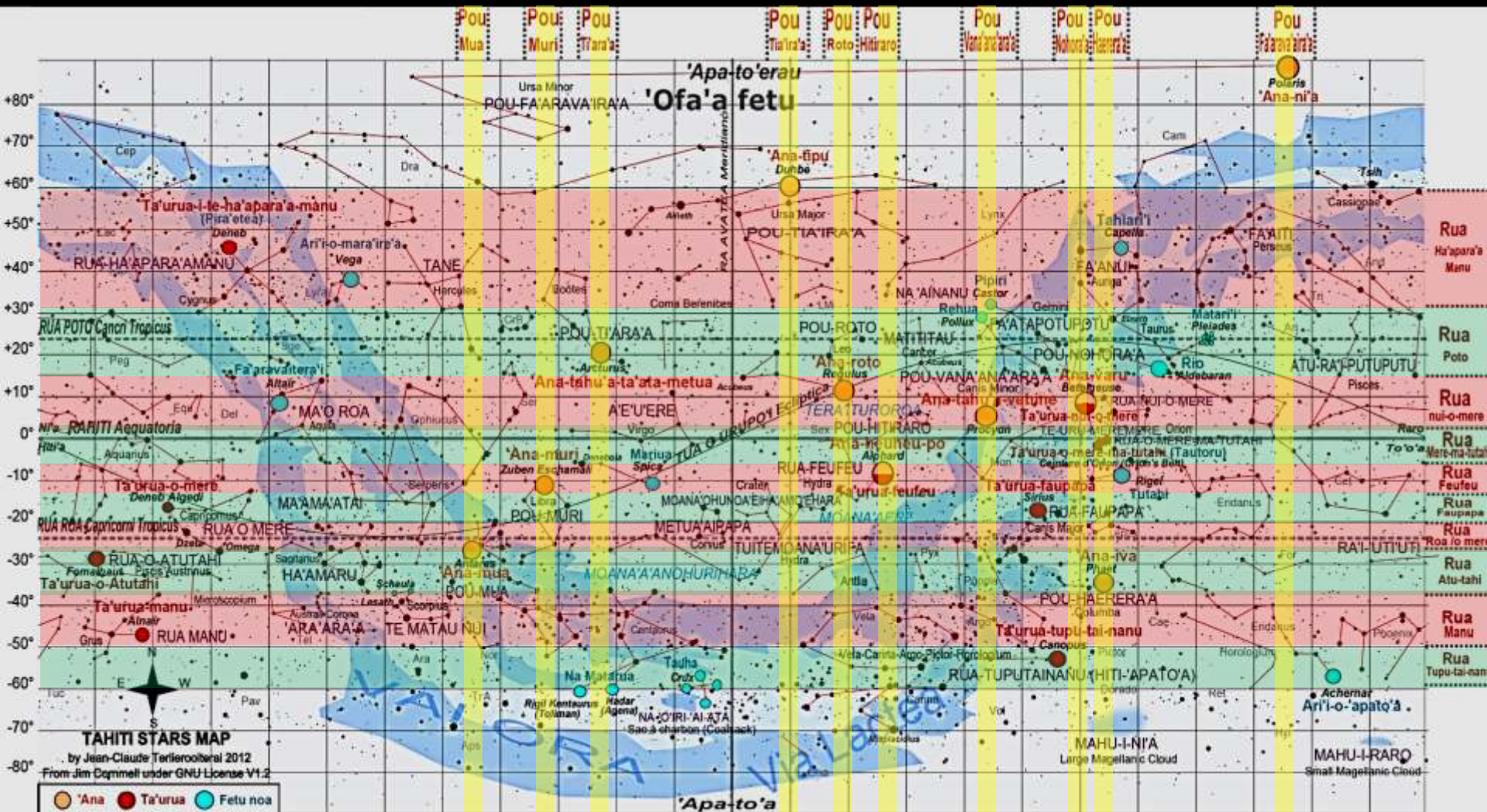
East

A POU is the meridian which, starting from a star *'Ana* at its peak, joined *'Anatīpū* "Dubhe" located in the vicinity of the North Pole (Anani'a "Polaris" if we are in the northern hemisphere)

Rua & Pou = assimilated with latitudes and longitudes

South Pole

Rua & Pou



Navigation Tahiti to Nuku-Hiva

'Ana-tipu
(Dubhe)

NORTH

Rua feufeu

2

Nuku-Hiva

Hiva-Oa

3

POU

Navigation suivant un Pou

Navigation suivant un Rua

Route réelle

Route directe

Vents et houle dominants

- 1 - Navigate to the North, to *Rua feufeu*, by aligning with a Pou
- 2 - Once *Rua feufeu* crossed, veer to the east to Marquesas is., a larger target
- 3 - Once reached the archipelago, reach the island-target

'Ana...x..

Tahiti

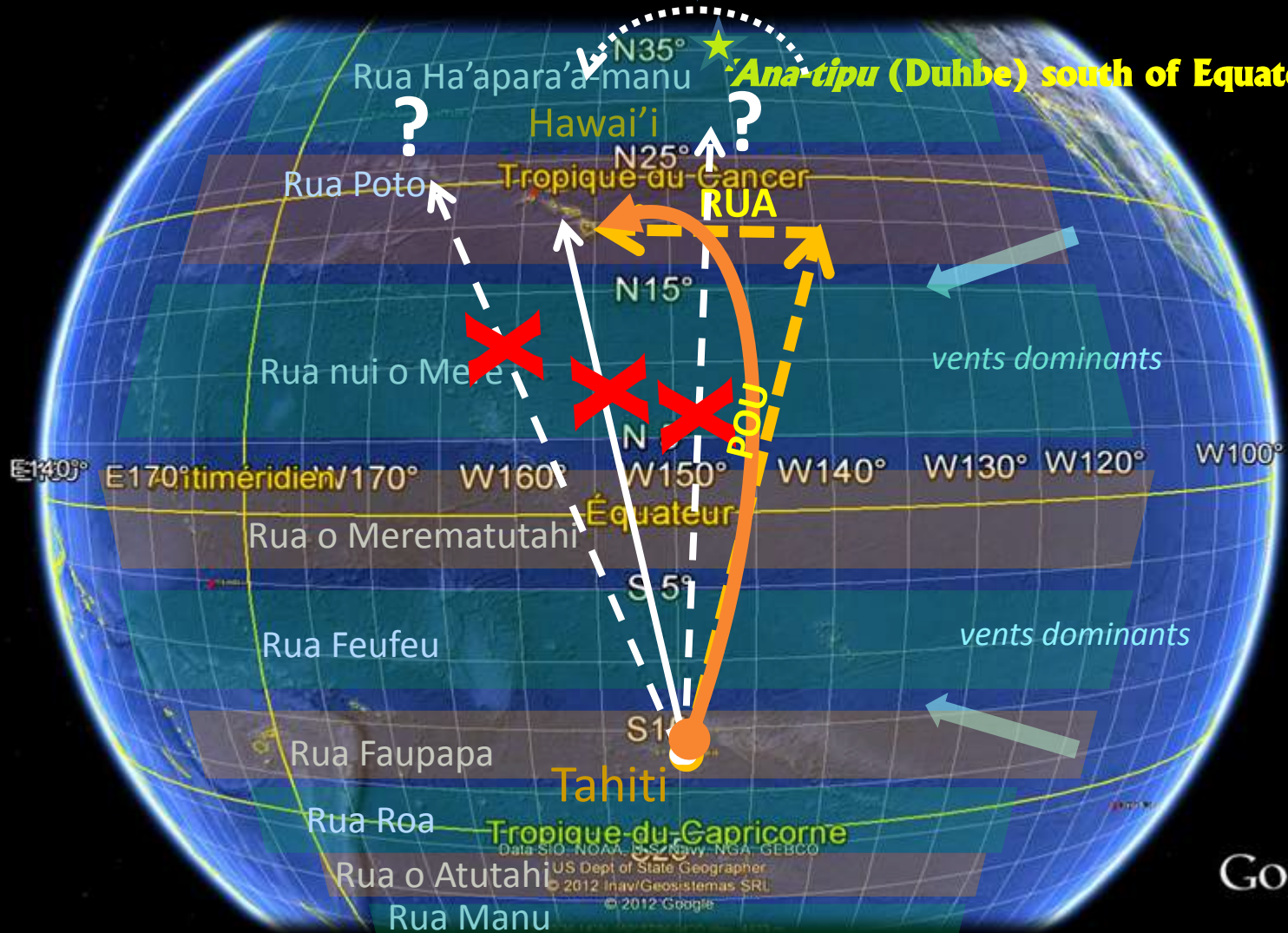
Rua Faupapa

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Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Google earth

Navigation Tahiti to Hawai'i

★ 'Ana-ni'a (Polaris) north of Equator
★ 'Ana-tipu (Duhbe) south of Equator



Data SIO, NOAA, U.S. Navy, NGA, GEBCO
US Dept of State Geographer
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ASTRONOMICAL NAVIGATION: BEYOND 120 MILES

Ra'ituarua

Ra'ituatahi

Hiti poto

Hiti marama

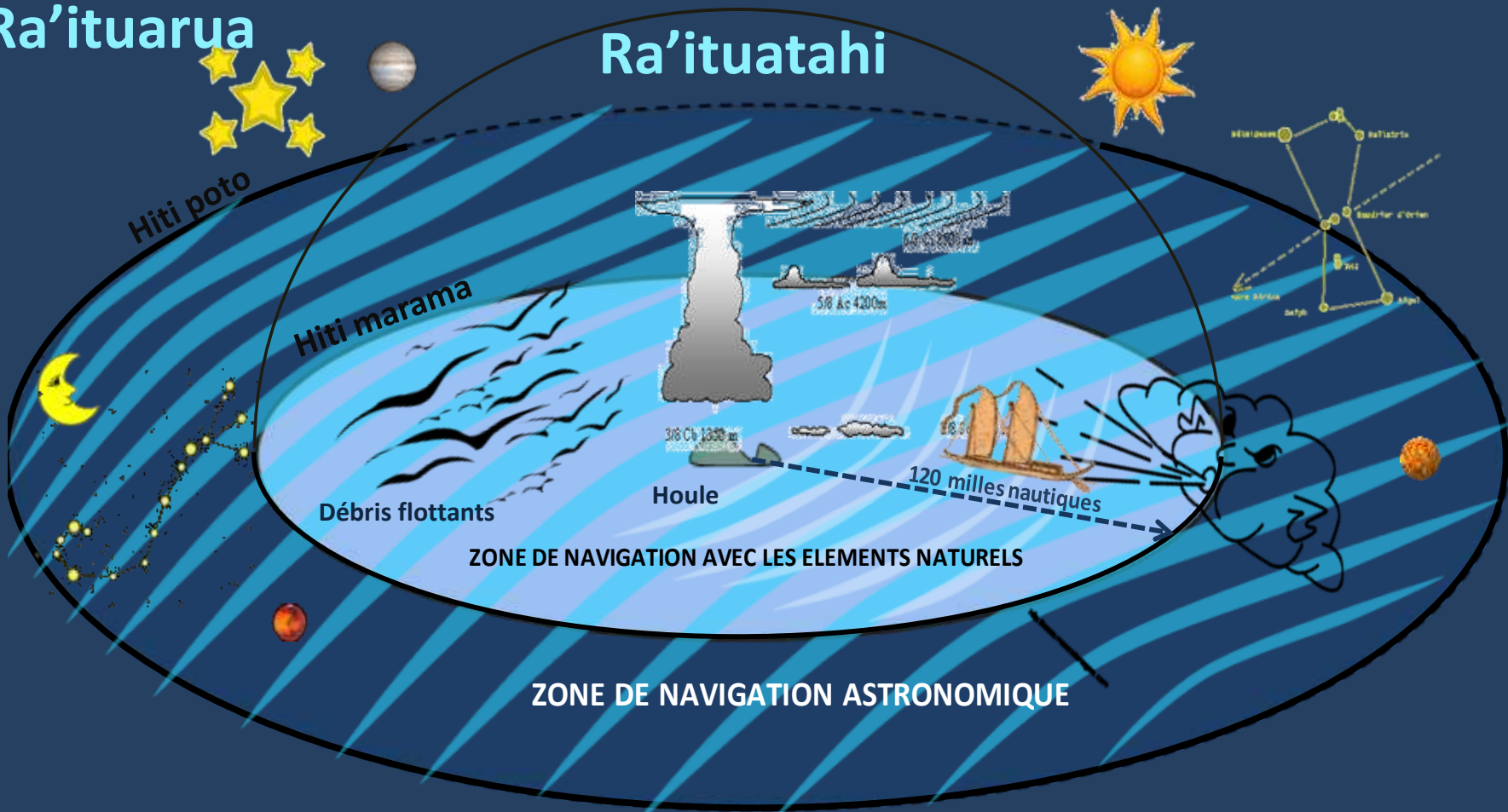
Débris flottants

Houle

120 milles nautiques

ZONE DE NAVIGATION AVEC LES ELEMENTS NATURELS

ZONE DE NAVIGATION ASTRONOMIQUE



NAVIGATION WITH NATURE: ENLARGE YOUR TARGET



An island is a target of ten kilometers, an archipelago is a target of several hundred km = it is preferable to aim an archipelago

NAVIGATION AVEC LA HOULE PAR TEMPS COUVERT

Les vents dominants génèrent une houle sur de grandes distances gardant sa direction pendant plusieurs semaines, un véritable compas. Le *fa'atere* garde son cap en maintenant un angle constant entre la houle et son *va'a*

Ouest

Nord

Est

Sud



THE SWELL NEAR AN ISLAND

(A)

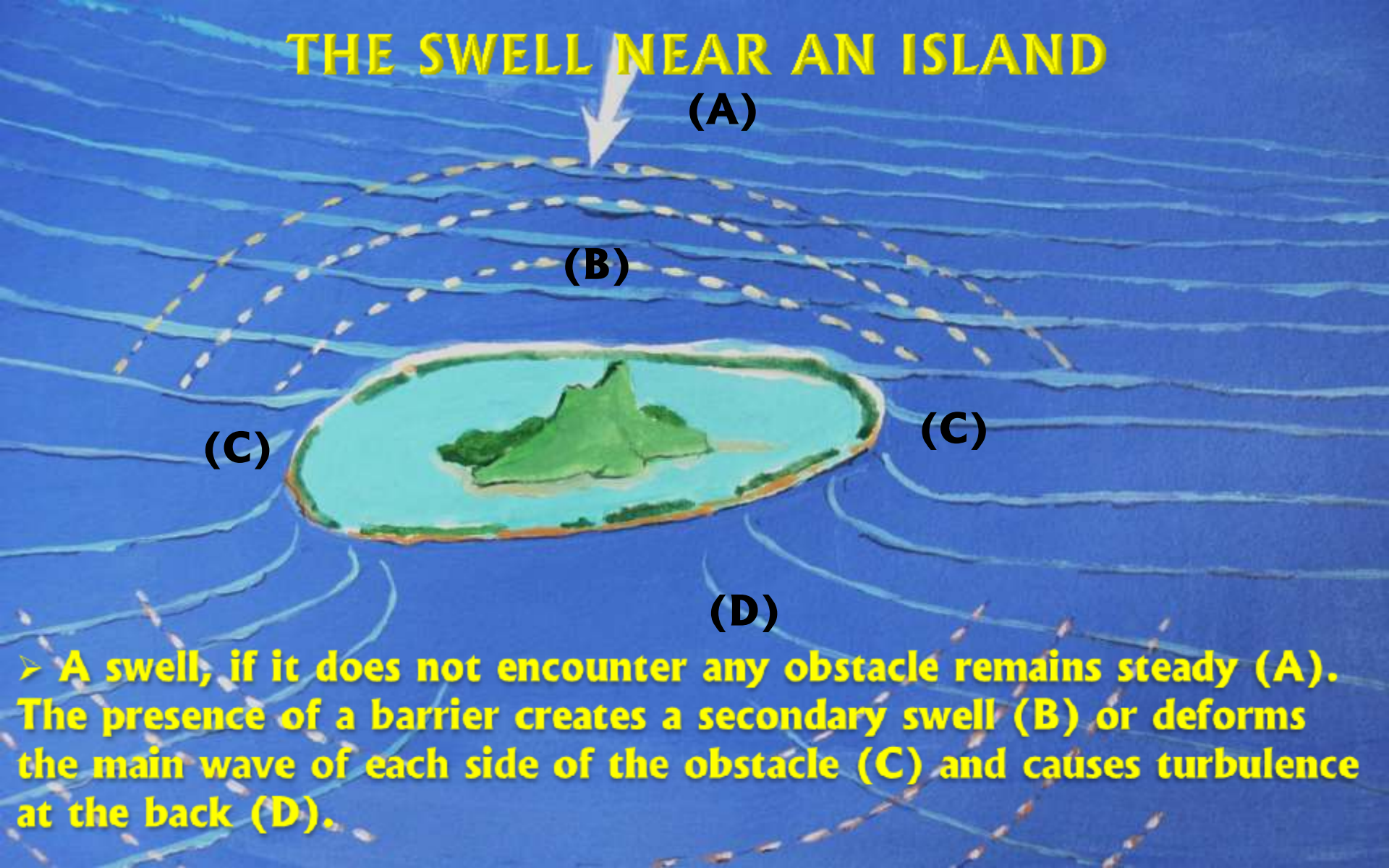
(B)

(C)

(C)

(D)

➤ A swell, if it does not encounter any obstacle remains steady (A). The presence of a barrier creates a secondary swell (B) or deforms the main wave of each side of the obstacle (C) and causes turbulence at the back (D).



BIRDS & CLOUDS

The flight of birds in the morning and evening, indicates the direction of the island, and the species, the range of action



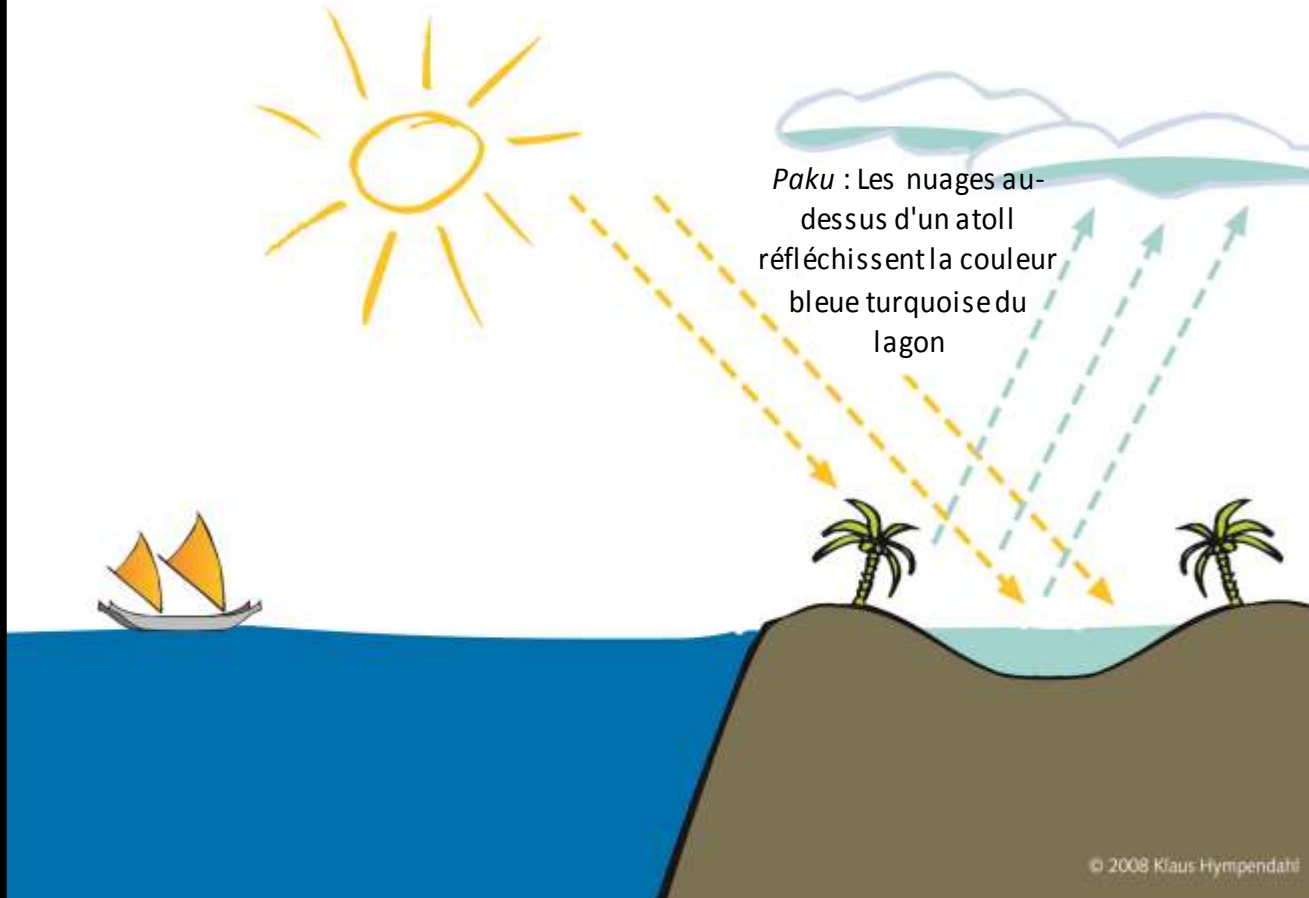
The warmth of the land, generates large clouds, motionless above the islands

RANGE OF ACTION OF THE BIRDS



COLOUR OF CLOUDS : PA'U (PAKU)

"PAKU" NUAGES COLORÉS



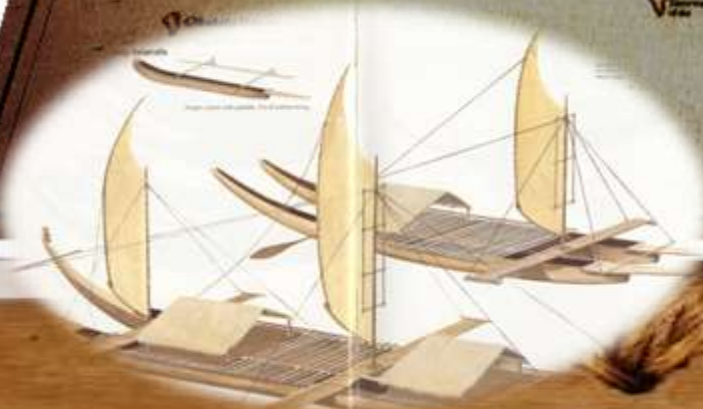


Māururu

Faatomoavaa TERIIEROOITERAI, 2014



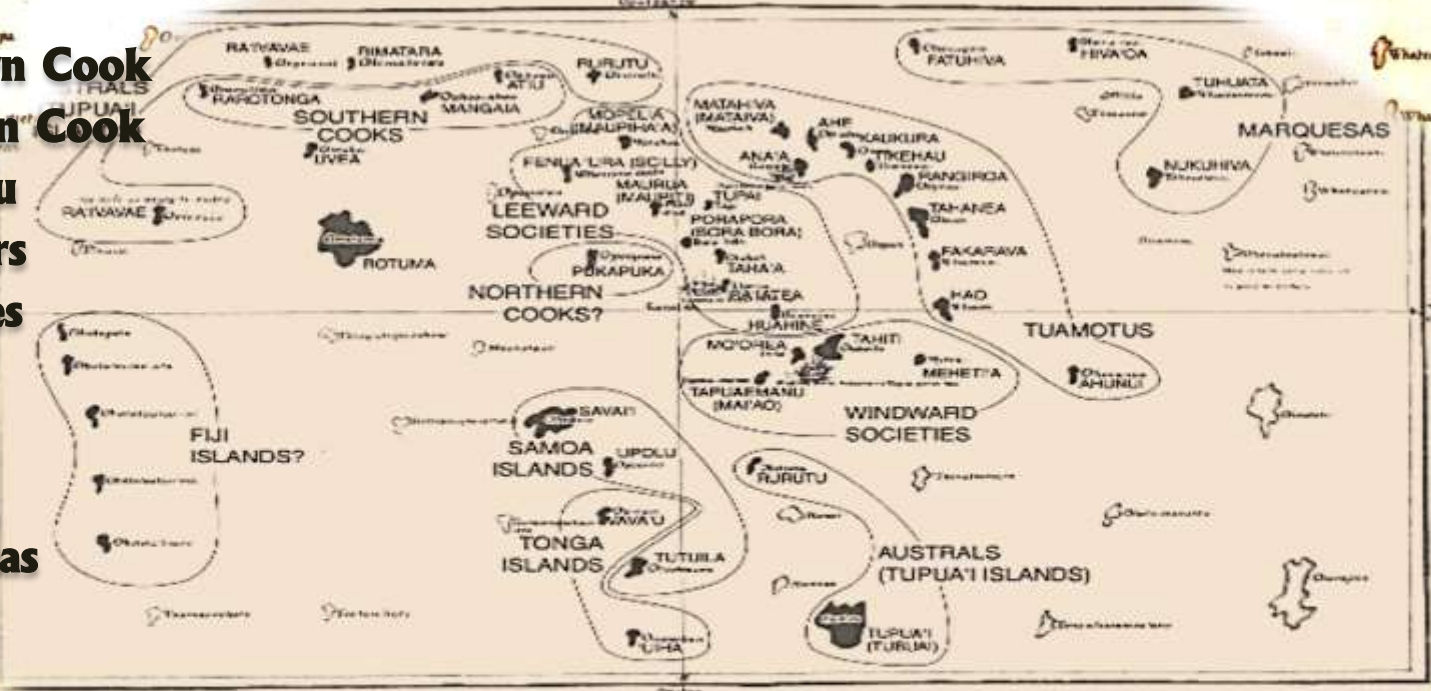
Geographical knowledge of Tupaia (Anne di Piazza)



Tupaia Chart

84 islands and 14 archipelagos identified :

- Society
- Northern Cook
- Southern Cook
- Tuamotu
- Gambiers
- Australes
- Pitcairn
- Tonga
- Samoa
- Marquisas
- Wallis
- Fiji
- Rotuma
- Tokelau

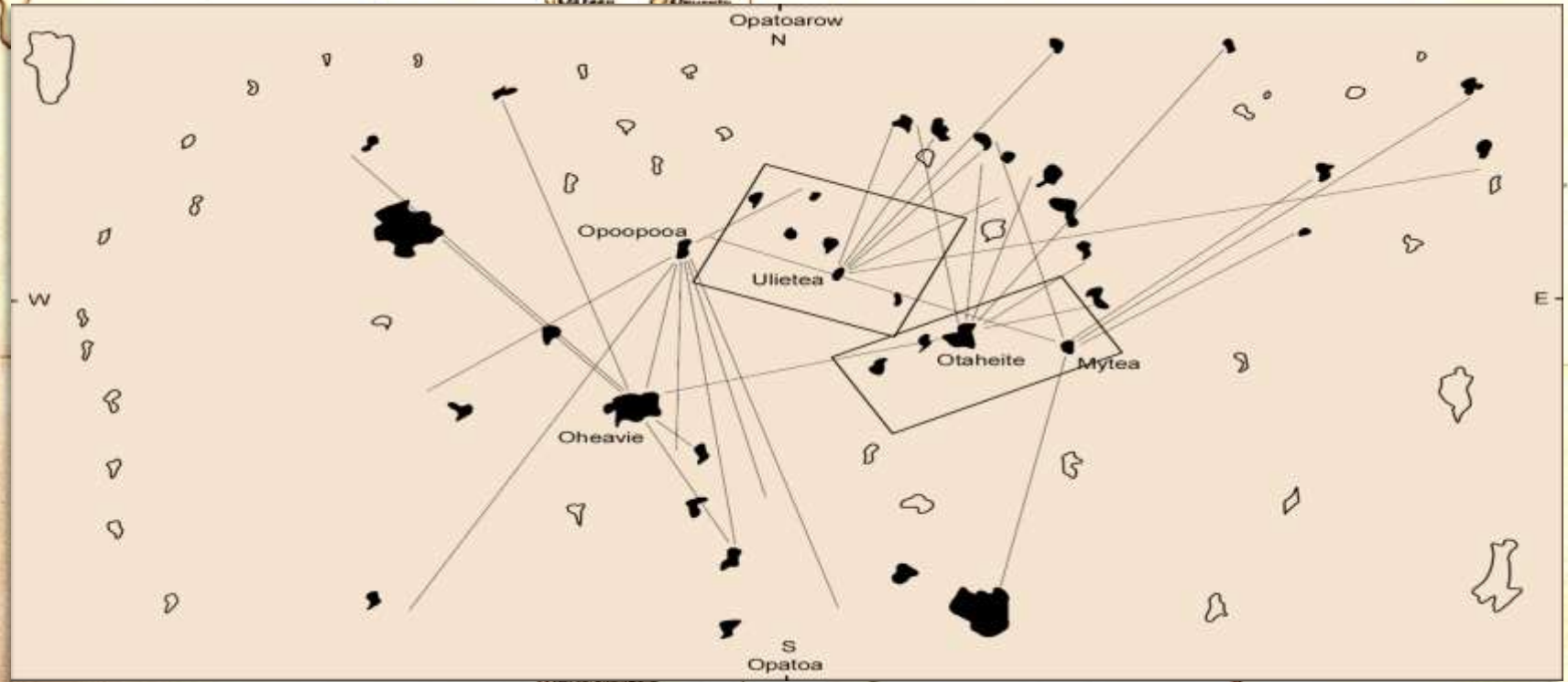


IDENTIFIED ISLANDS ON COOK'S VERSION OF "THE CHART" AND THEIR GROUPING BY ARCHIPELAGO. The islands that can be identified with varying degrees of certainty are shaded and labeled in block letters. Problems with Cook's spelling of the names of islands, along with Tupaia's names for many islands, are noted in the margin of the chart.

seventy-four islands on Tupaia's chart. Grouping islands by archipelago, and then comparing with the actual distribution of islands (see map 13.4), shows that many of the islands were misplaced on the chart, perhaps because Tupaia misunderstood the Tahitian names or reversed them in drawing. The directions

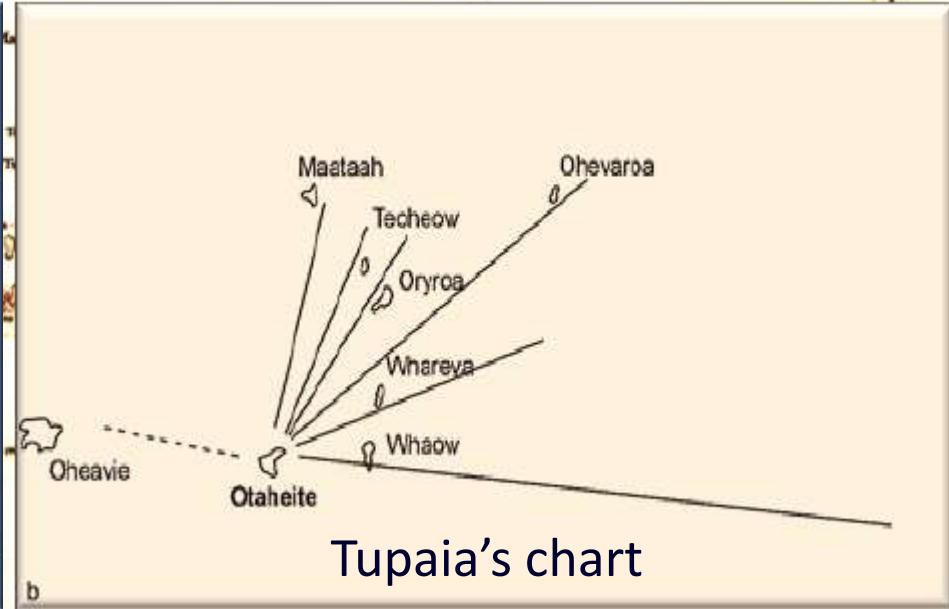
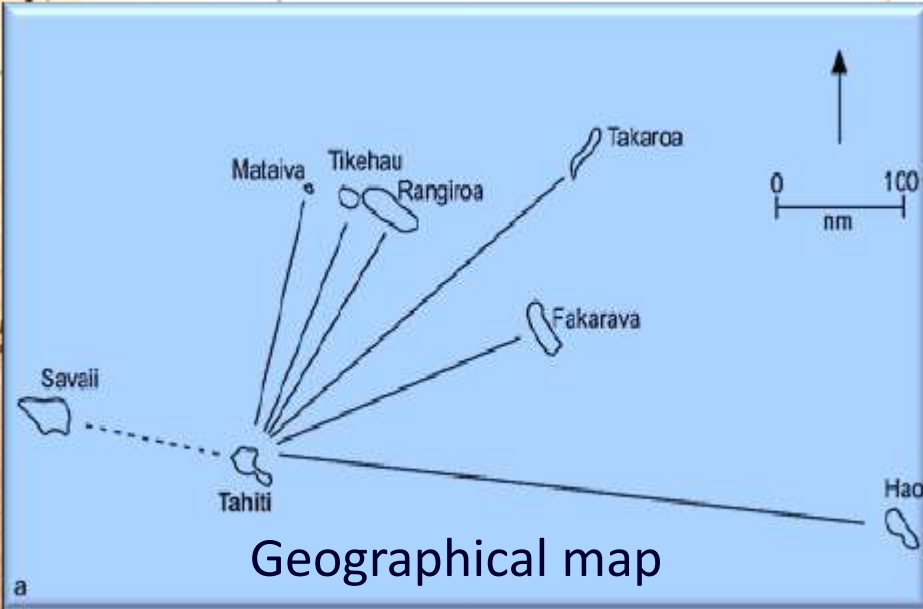


Tupaia chart (Anne di Piazza)



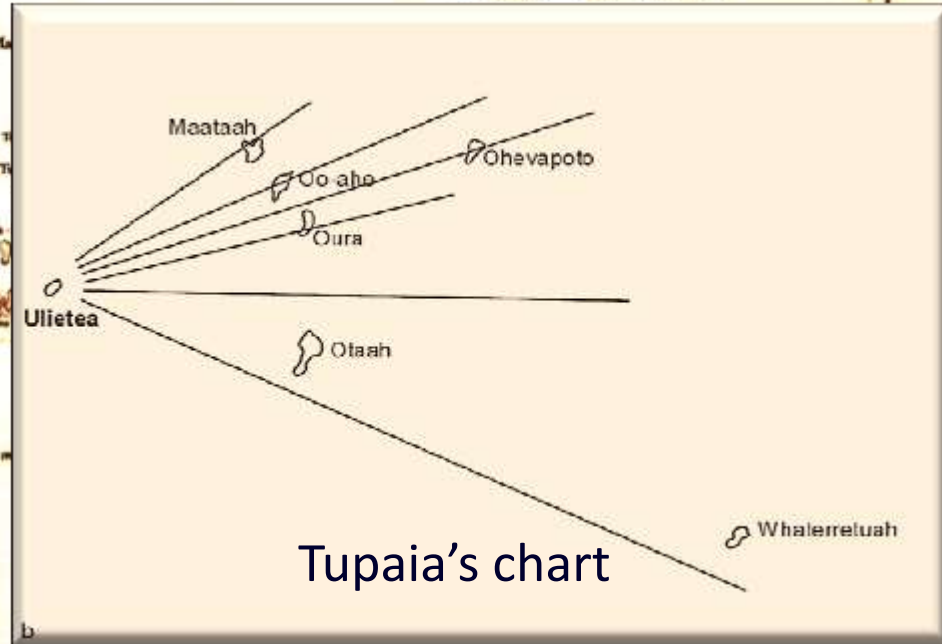
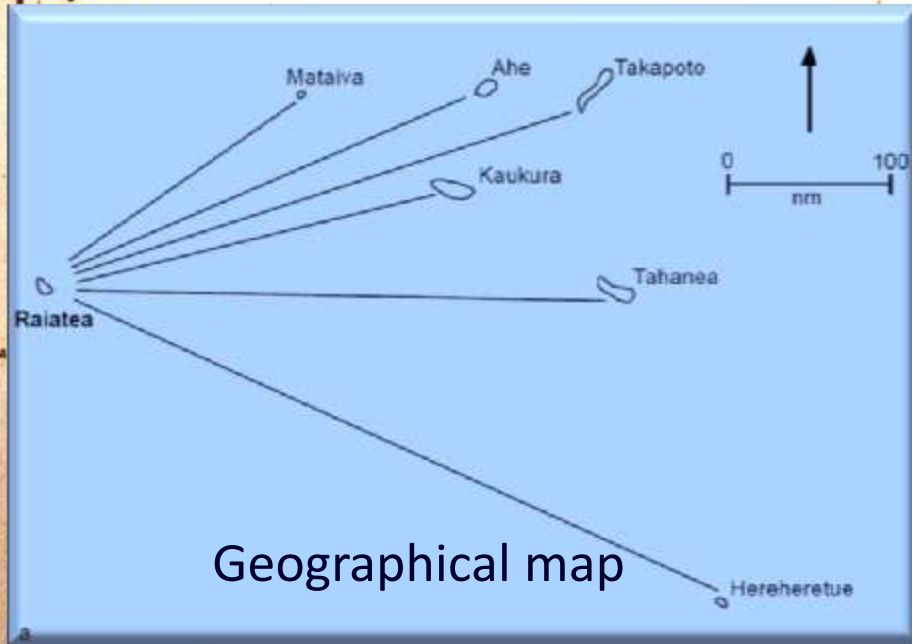
On his map Tupaia has positioned 5 reference Islands, Tahiti, Meheti'a, Ra'iatea, Pukapuka (Cook Is.) and Savai'I, starting points towards thirty targets islands

Tupaia (Anne di Piazza)



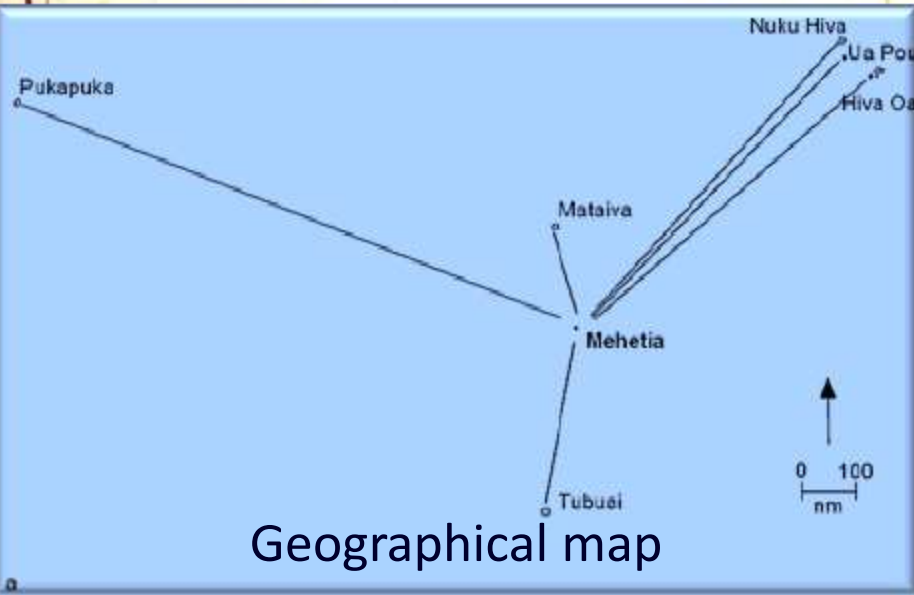
In the example above, the reference island is Tahiti, target islands are Mataiva (Maataah), Ti'ehau (Teoheow), Ra'iroa (Oryroa), Ta'aroa ou Hiva'oa (Hevaroa), Fa'arava (Whareva), Hao (Whaow) et Savai'i (Oheavie) correctly positioned in azimuth

Carte de Tupaia (Anne di Piazza)

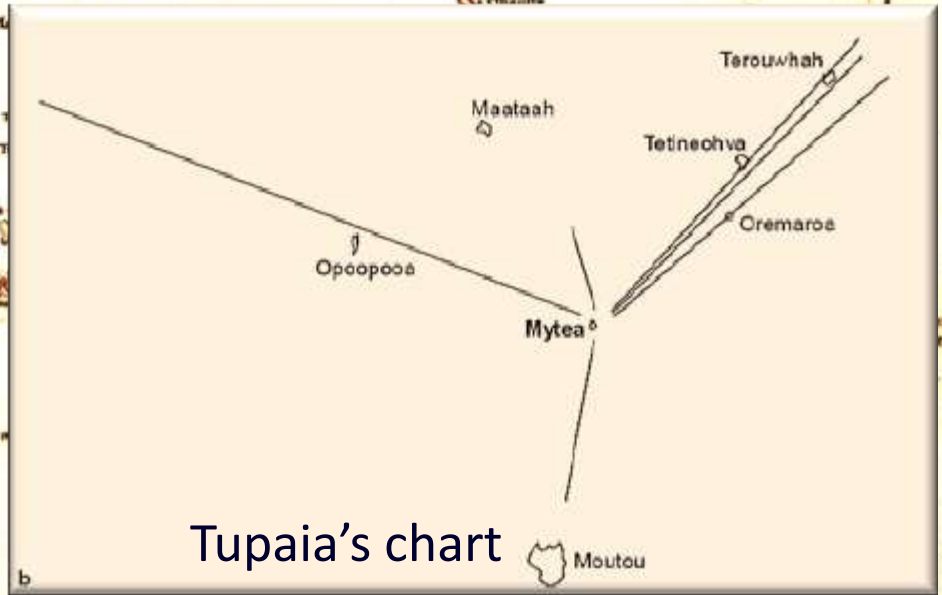


Above, the reference island is Ra'iatea – the targets islands are Mataiva (Maataah), Ahe (Ooaha), Ta'apoto (Hevapoto), 'Au'ura (Oura), Tahanea (Otaah) et Hereheretue (Whaterretuah), correctly positioned in azimuth

Carte de Tupaia (Anne di Piazza)



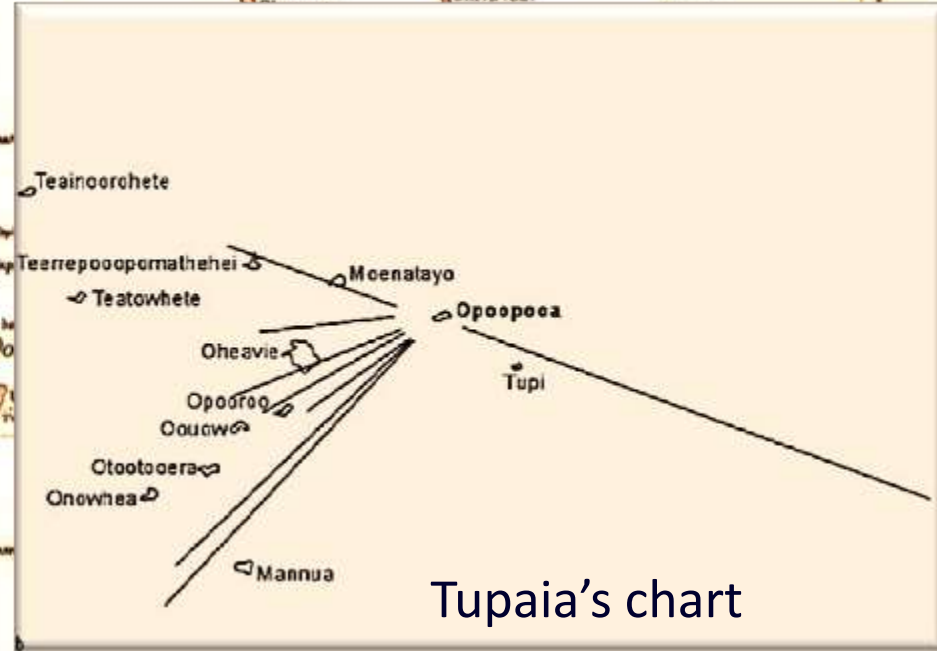
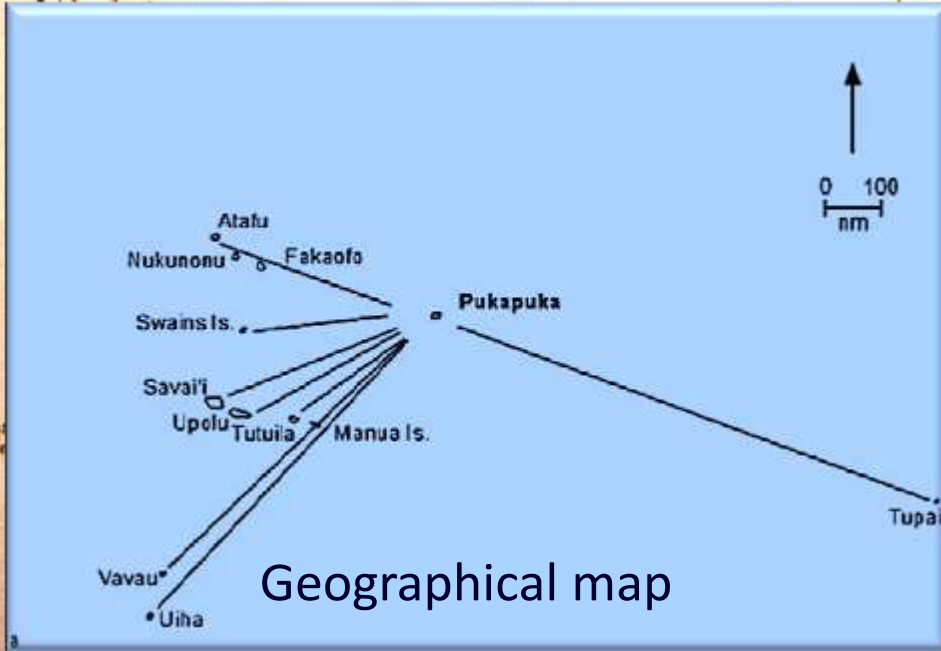
Geographical map



Tupaia's chart

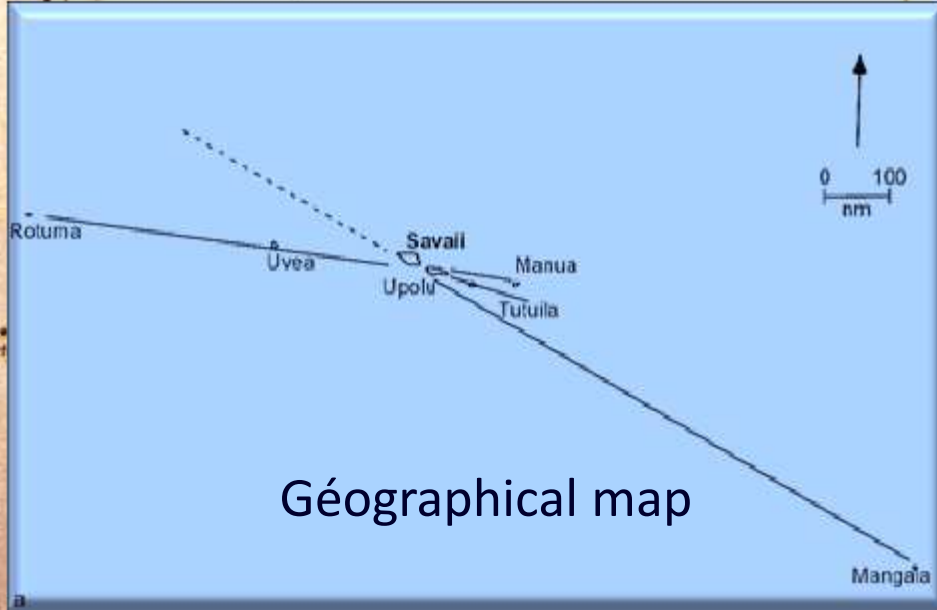
➤ Above, the reference island is Meheti'a (Mytea), the targets islands are Pukapuka or Pu'apu'a (Opooopoo), Mataiva (Maataah), Nu'u-Hiva (Tetineohiva), 'Ua-Pou (Terouwhah), Hiva-Oa (Oremaroe), Tupua'i (Moutou), correctly positioned in azimuth

Carte de Tupaia (Anne di Piazza)

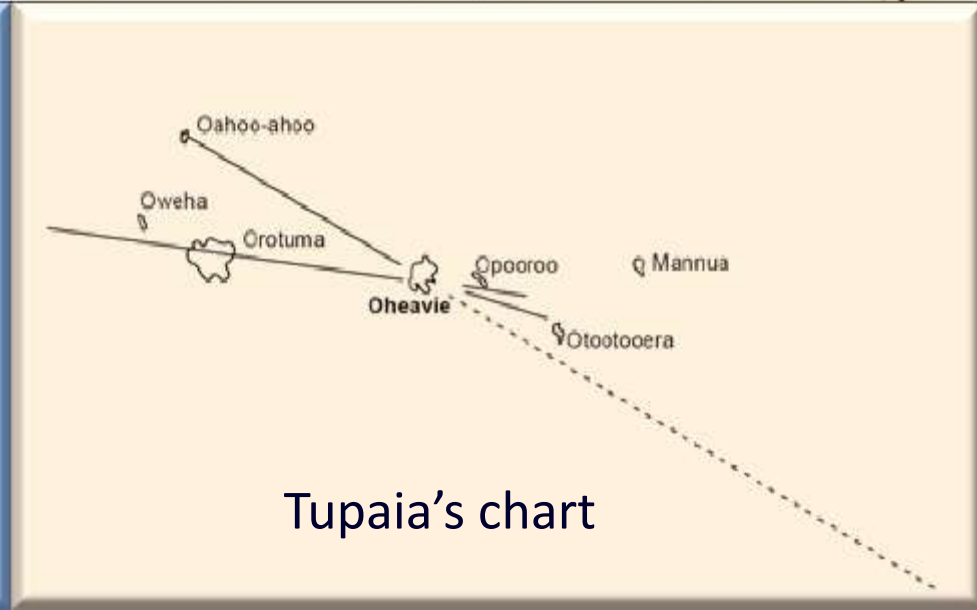


➤ Above, the reference island is Pukapuka (Opoopooa), the targets islands are Savai'i (Oheavie), 'Upolu (Opooroo), Tutuila (Ootooera), Manu'a (Mannua), Vavau (Oouow), Uiha (Onowhea), Tupai (Tupi), Fakaofu (Moenatayo), Atafu (Teainoorehete), Nukunonu (Teerrepoopomathehei), Swainn Is (Teatowhete) correctly positioned in azimuth

Carte de Tupaia (Anne di Piazza)



Géographical map



Tupaia's chart

- Above, the reference island is Savai'i (Oheavie), the targets islands are Tutuila (Ototooera), Manu'a (Mannua), Rotuma (Orotuma) et 'Uvea (Oweha), correctly positioned in azimuth

The Tupaia map is the one that the Tahitians had engraved in their memory in 1769. It perfectly demonstrates the geographical knowledge of the Tahitians and their ability to implement their intelligence in understanding the astral movements and phenomena generated by the nature.

The concepts developed are part of a real science. It comes to break the idea that a society of oral tradition could not have access to science and would have remained at the stage of the myth.



Māururu

Faatomoavaa TERIIEROOITERAI, 2014

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