

The background of the slide is a photograph of several tall palm trees against a sky filled with soft, white, textured clouds. The trees are silhouetted against the lighter sky, and their fronds are visible. The overall scene is a tropical landscape.

# **ATMO 102 Pacific Climates and Cultures**

## **Lecture 11: Hawaiian Winds**

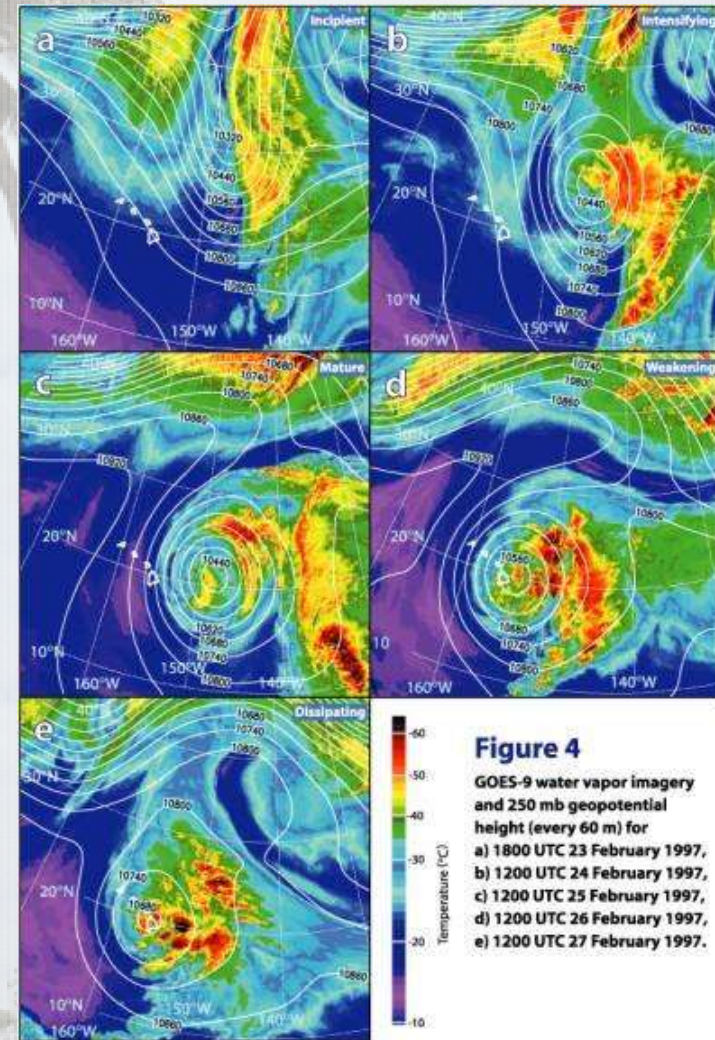
# Local Wind Examples Continued

- **Navigation Close to the Islands**

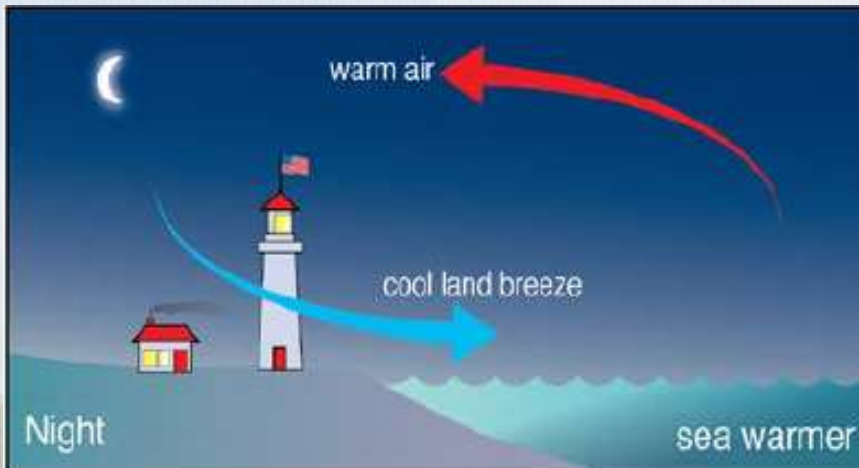
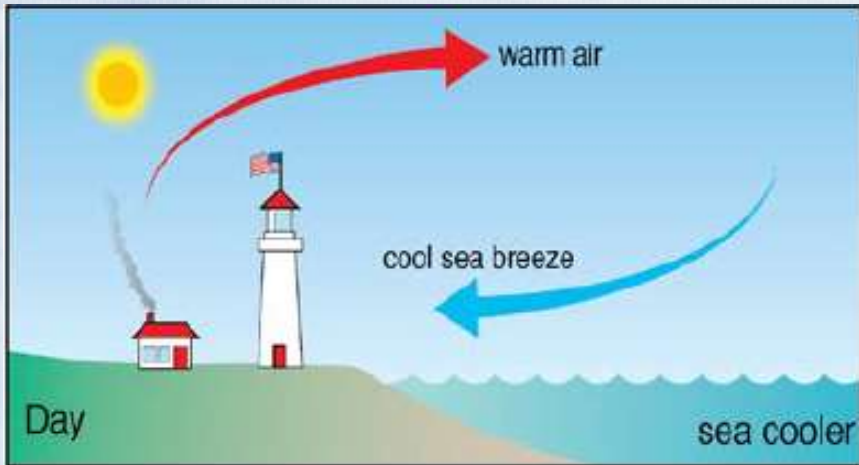
- Near Hawai'i Island the local winds modify navigation and names can warn seafarers
  - Winds from the mountains are known as the **Mumuku**
  - Winds from the shore are known as the **Ho'olua**
  - A strong Kona wind is the **Kula'ipau** – which mean to completely knock over

- **Seasonal Winds** - There are only 2 seasons in Hawaii

- **Kau** - Summer (May to October)
- **Ho'oilo** – Winter (November to April)
  - Kona winds caused by Kona storms (cold upper level storm) that develops in winter, is mentioned many times.



# Hawai'i's Sea-Land Breezes



- **Land-Sea Contrasts Drive the Sea-Land Breezes**
  - **Day – land heats up more rapidly**
    - heated air rises, low pressure over land, and high pressure (cool ocean) off shore.
    - wind flows from ocean to land
    - Called a **sea-breeze** and often produces clouds and showers over the mountains.
  - **Night – land cools off faster than the sea**
    - After land cools faster, the ocean is now relatively warmer
    - relatively warmer air over ocean rises
    - air cooled over land flows downslope and out to sea
    - Called a land-breeze

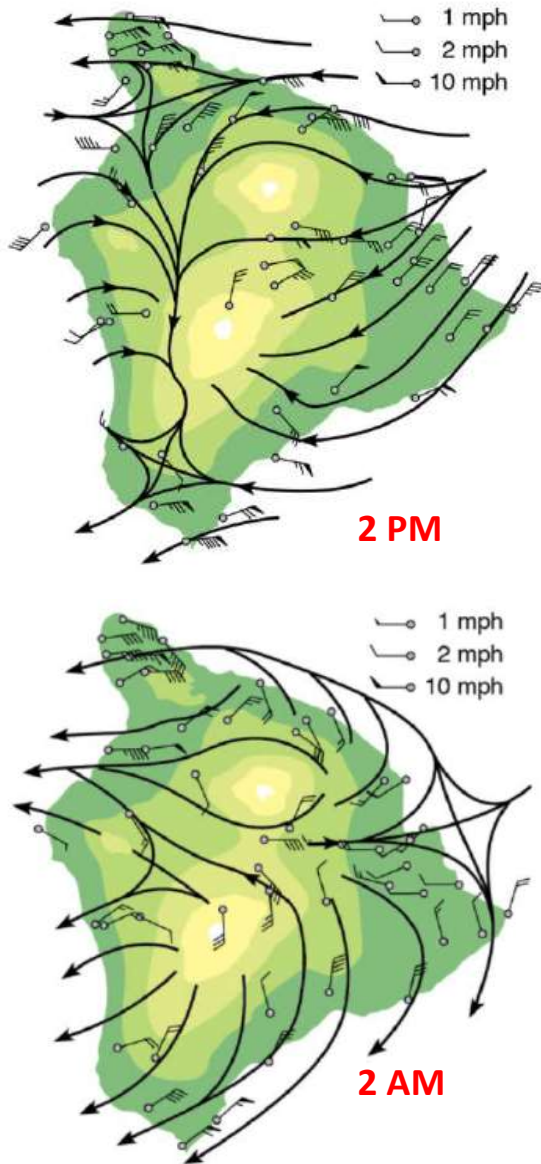


## Oahu Sea-Breeze Clouds



- **Sea breeze** front from Pearl Harbor to Waikiki
- Can see clouds developing over Waikiki and Manoa
- You can see the **orographic clouds** over the Ko'olaus.

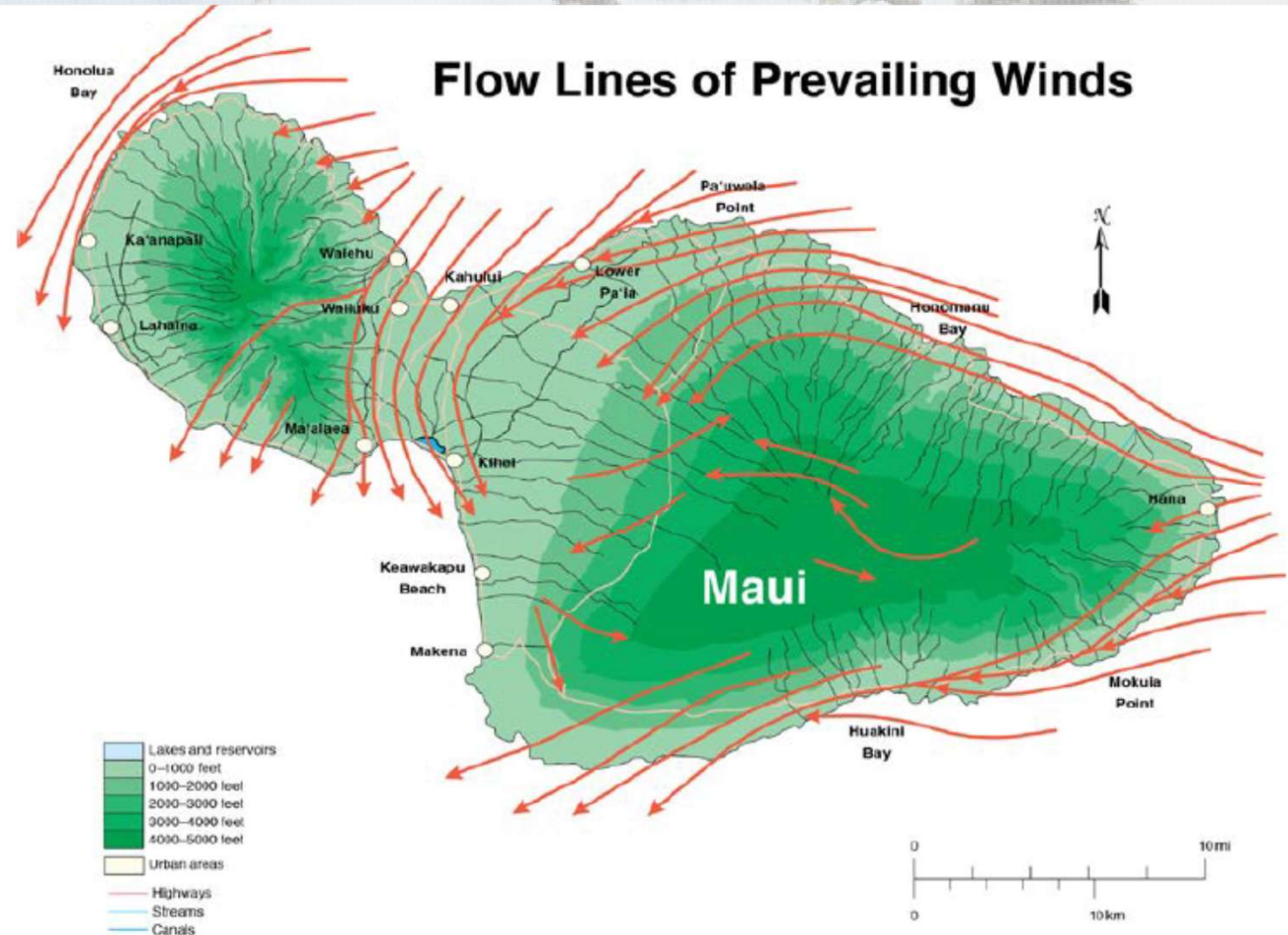
# Hawai'i's Sea-Land Breezes



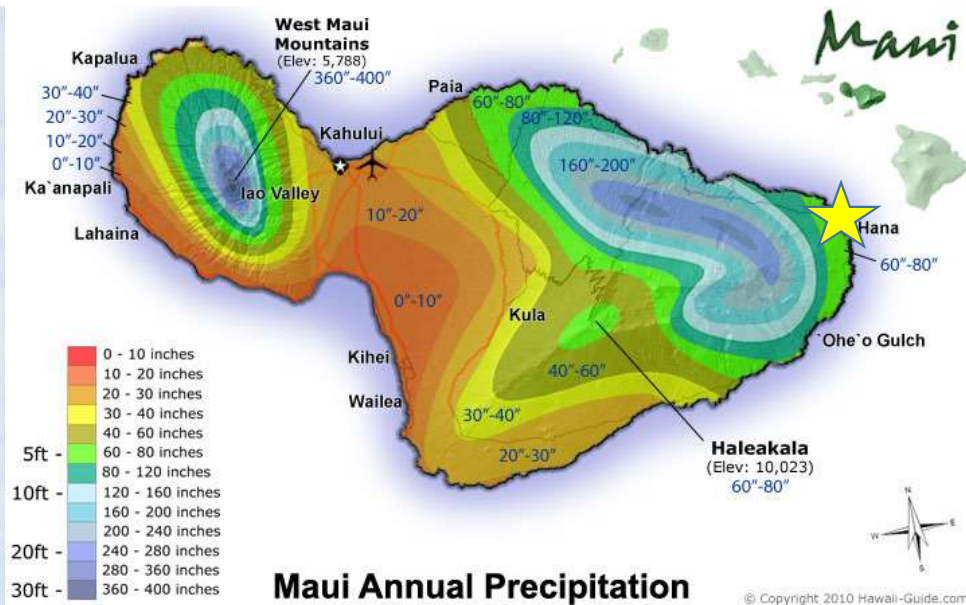
- **Different strengths for each Island and depends on:**
  - Height of the mountains
  - overall size of the island
  - strength of the large-scale winds at any one time
- **Maui and Island of Hawai'i**
  - taller volcanoes block the large-scale flow
  - allow heat to build up on the leeward sides
    - even when the large-scale winds are moderately strong
  - increases the strength of the daily sea breeze over the lee slopes.
- **Kaua'i and O'ahu**
  - Have smaller mountains that do not block the flow
  - only experience well developed sea-breezes under lighter large-scale wind conditions.

# Flow Splitting on Maui

- **Streamlines** or flow lines (in red) are drawn parallel to the local wind direction
- **Show impact of the mountains** on the flow during the afternoon on a typical trade-wind day.

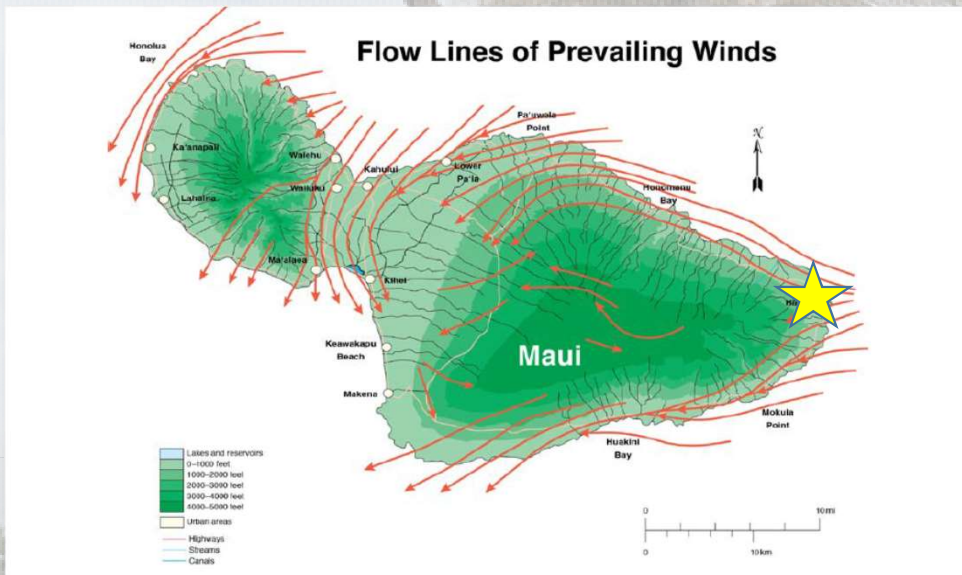






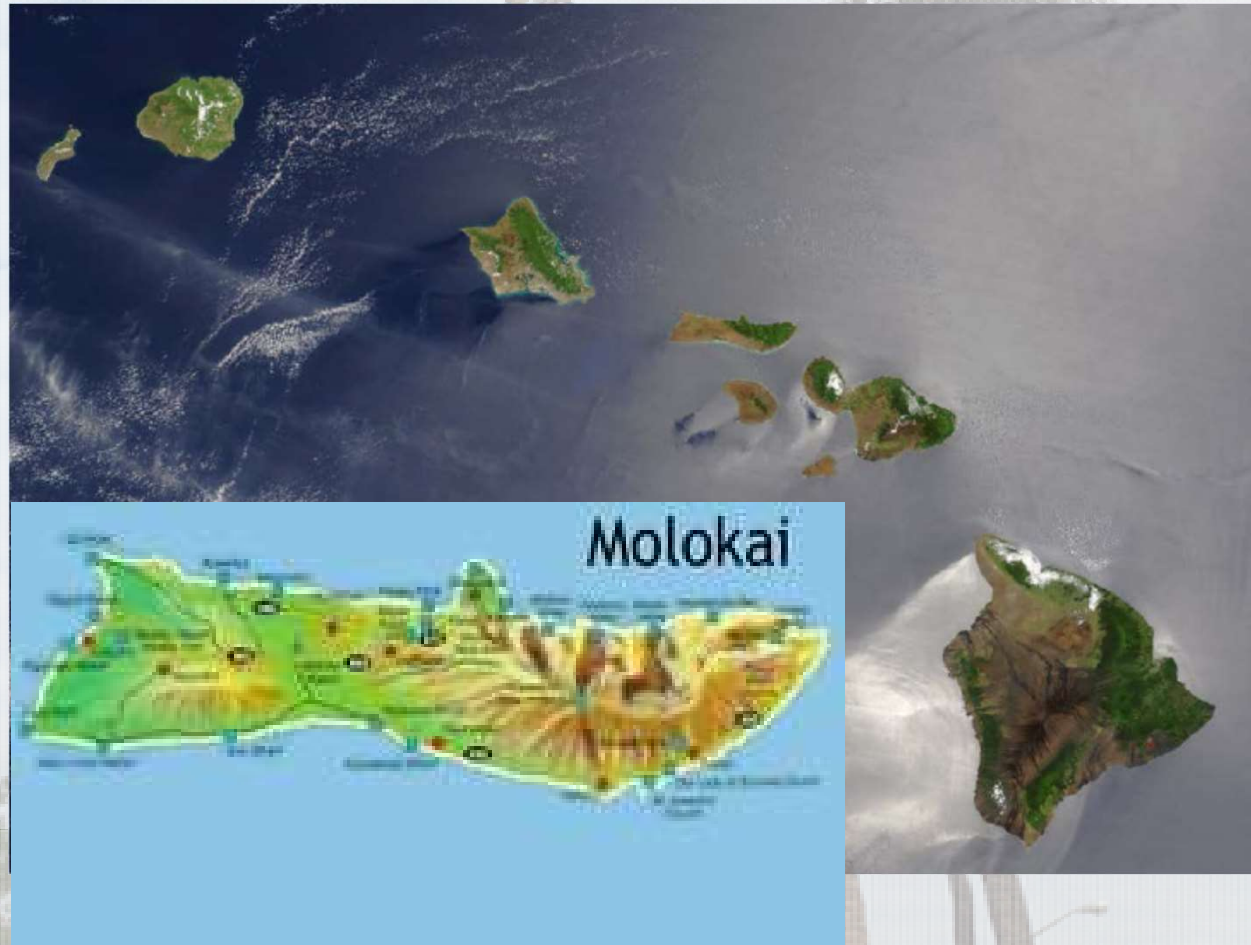
# Why is Hana so wet?

- Hana is on the Windward side
  - This is where the trade winds split, swirl around and break in many directions
  - Haleakala breaks the wind, causes orographic clouds and heavy precipitation



# Topography, Wind, Rain & Vegetation

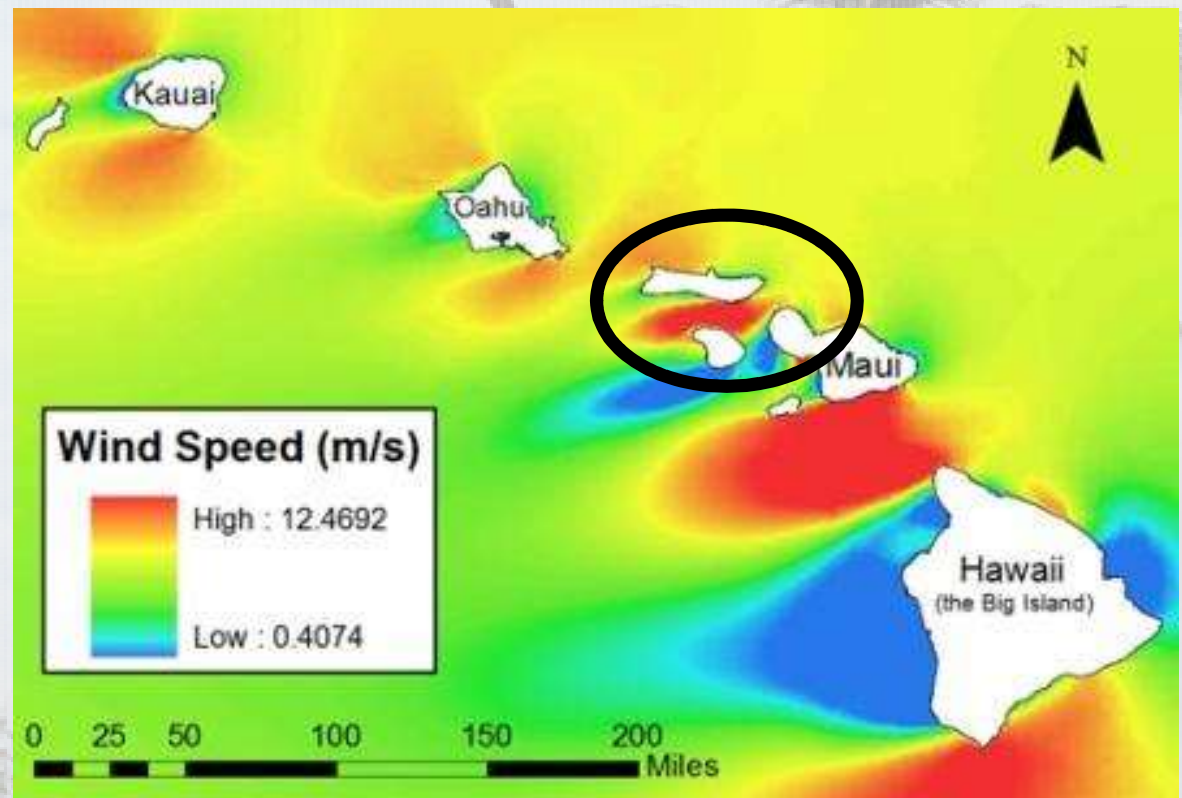
- Moloka'i – the island of the winds
  - Mountains play a smaller role
  - Winds can pass easily over
  - western half is dry (no orographic rainfall)
  - eastern half is wet due to the small mountain range
- All the Islands have a wet region and dry region
  - Wet regions are associated with the windward sides
  - Dry regions are associated with the leeward sides



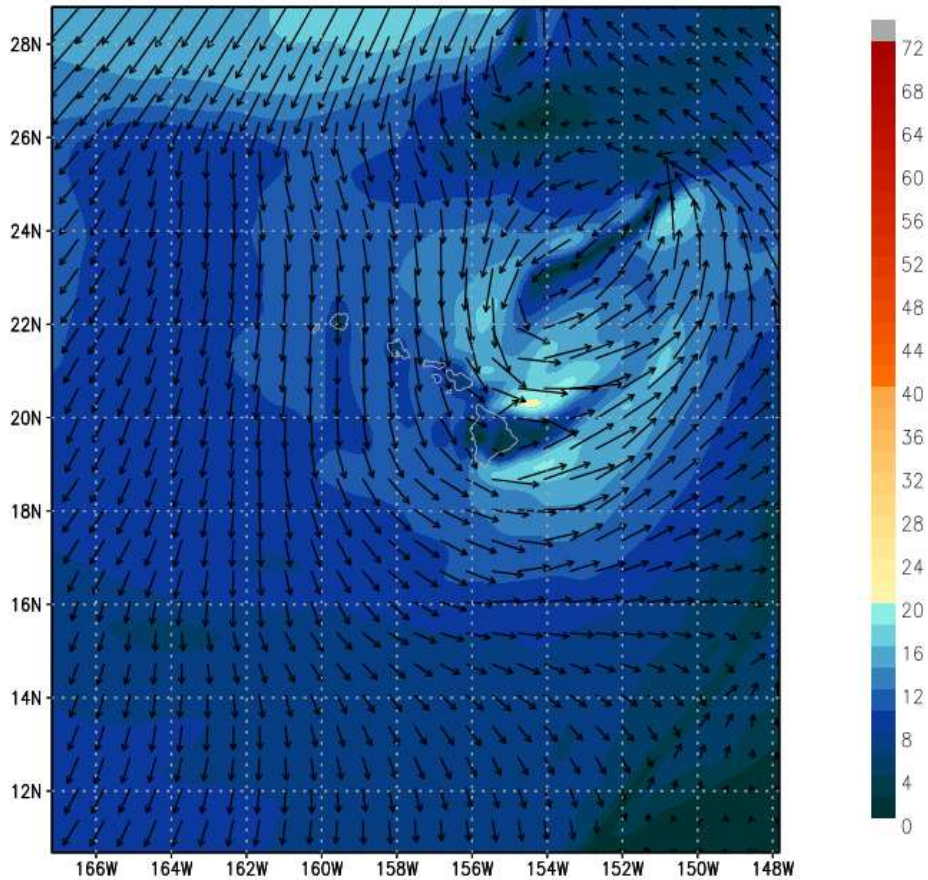


# Increased Wind Speeds Between Islands

- Several articles mention the **channel between Moloka'i and Lāhaina, Maui.**
  - Dangerous for Navigating
  - Increased wind speeds due to the funneling effect of how close the islands are and the topography
  - Cause large waves/swells



10m Wind [m/s] 2019021112 run  
Valid 12:00 UTC Mon 11 Feb 2019 - 02:00 HST Mon 11 Feb 2019 t = 0 hr



Developed by the Mauna Kea Weather Center (MKWC) in cooperation with the University of Hawaii Department of Meteorology  
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# Forecasted Regional Surface Winds

- [www.weather.Hawaii.edu](http://www.weather.Hawaii.edu)
  - Go to the bottom right thumbnail image for WRF Model Output
  - Then choose Winds
  - Then choose Surface
- Normal Flow Example(October 2015):
  - Trade winds are visible
  - Counter-clockwise rotating system visible
- Today's Forecast with the Kona Low.

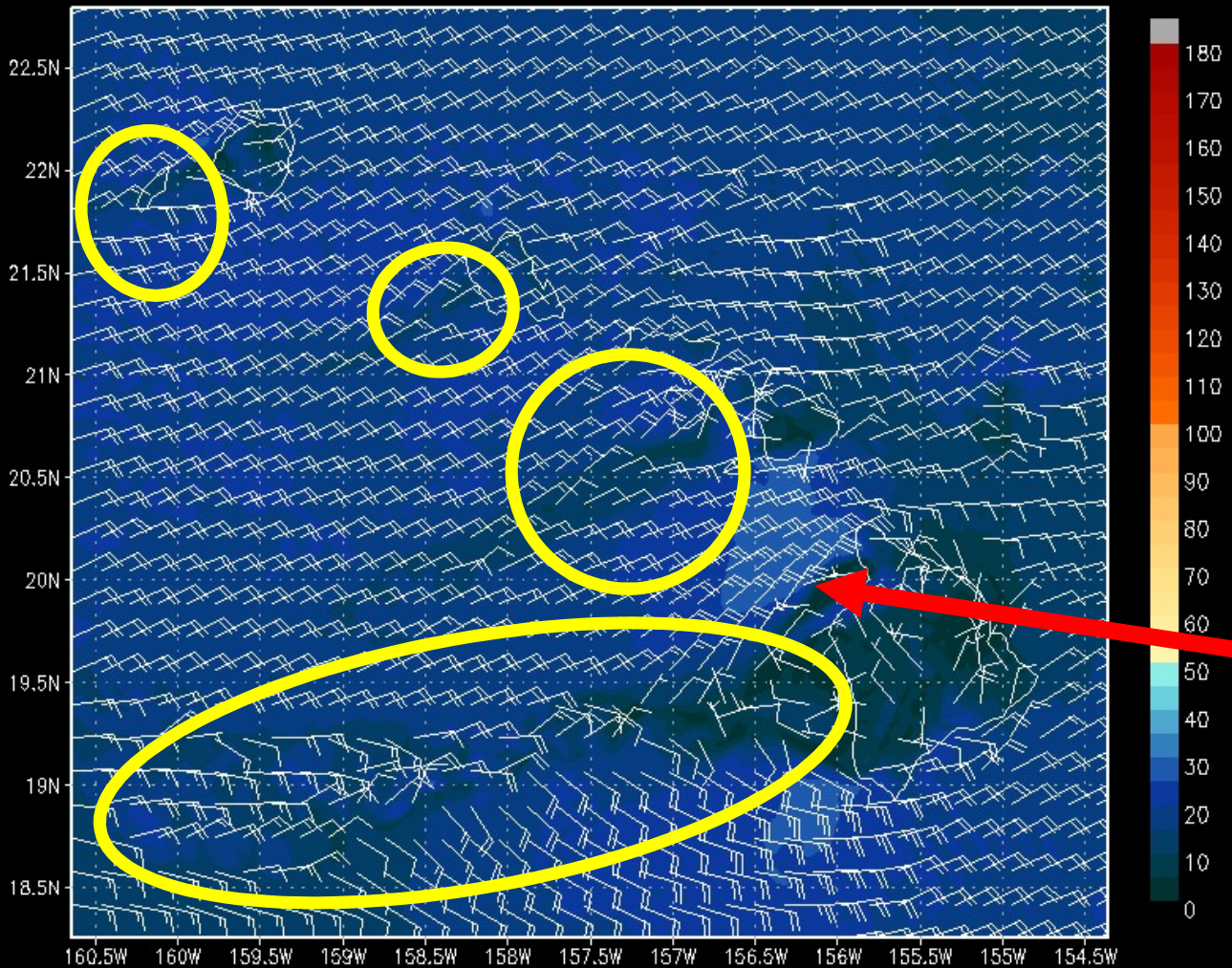


0.999 eta level winds [kts]

20150928 12 run

Valid 0:00 UTC Thu 1 Oct 2015 – 14:00 HST Wed 30 Sep 2015

t = 60 hr



Developed by the Mauna Kea Weather Center (MKWC) in cooperation with the University of Hawaii Department of Meteorology

## Forecasted Surface Winds

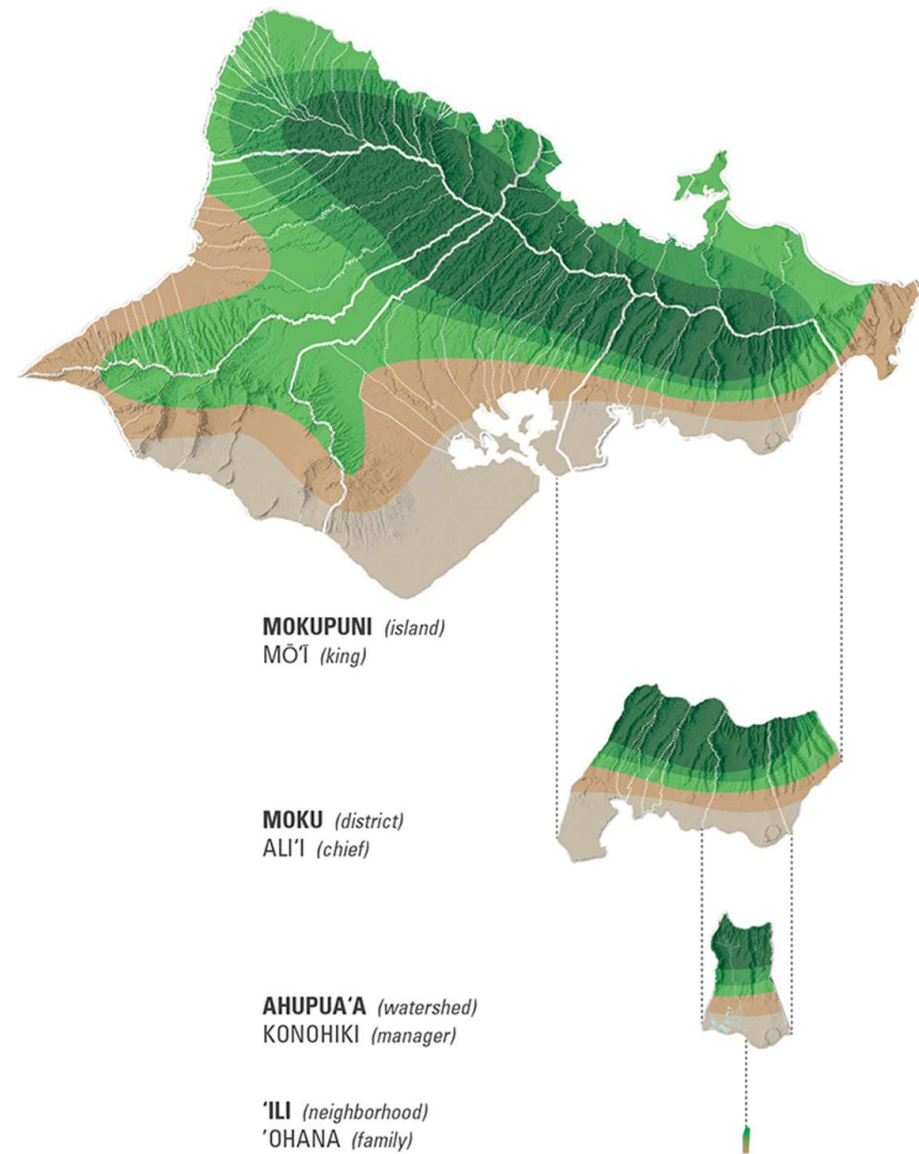
- **Disturbance** in the trade winds by the islands is clearly visible
- **Wind speed increases** noticeable between Hawai'i and Maui.



# What are Ahupua'a?

- An **ahupua'a** is a section of land.
  - The borders of each ahupua'a usually follow natural boundaries, like mountain ridges or streams.
  - Ahupua'a can stretch from the mountain ridges to the coral reef system.
  - Ahupua'a vary in size. Some are as small as 100 acres. Others are as large as 100,000 acres.
  - **Each ahupua'a has the necessary foods and materials for 'ohana (families) to live comfortably.**

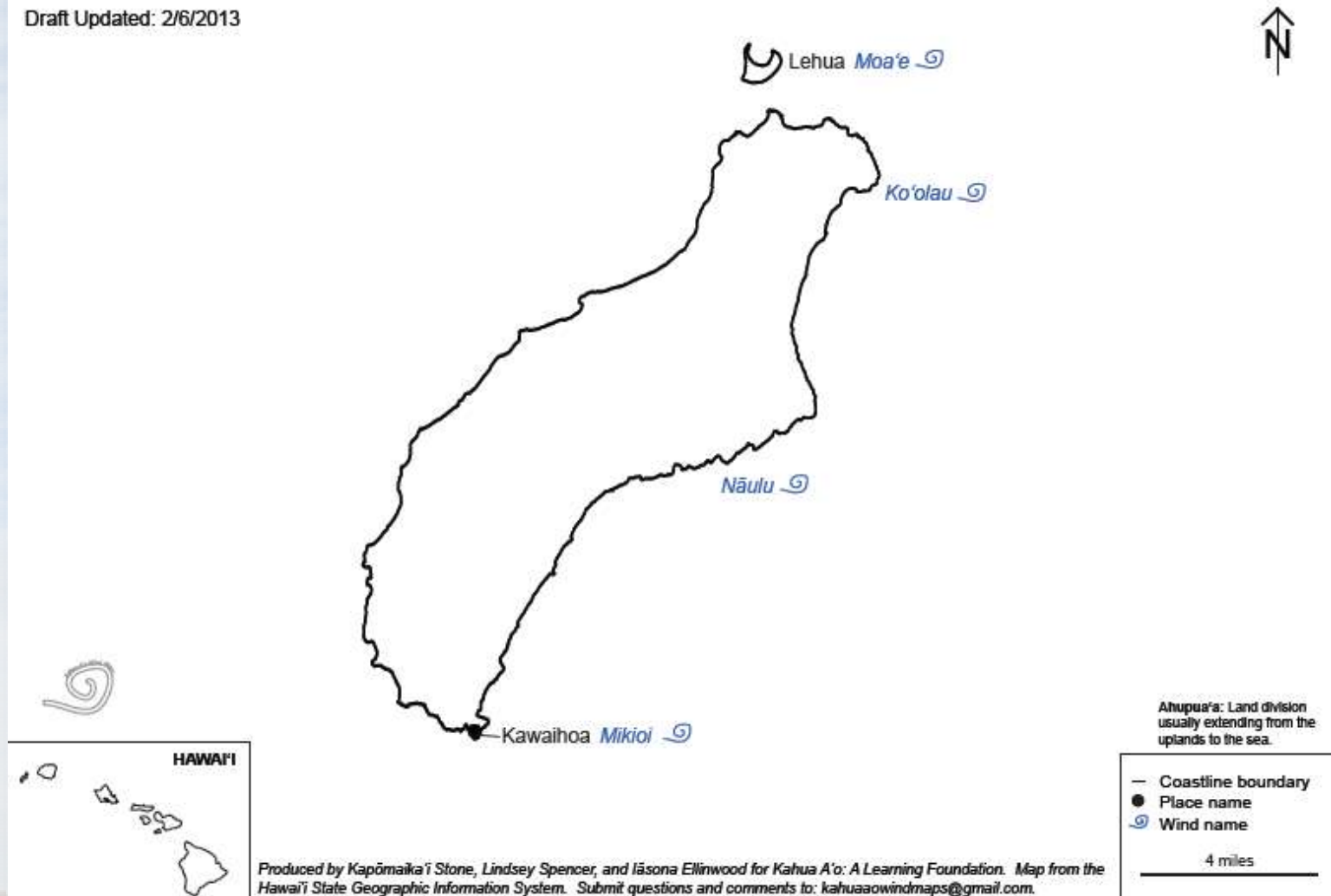
Info and images taken from:  
[http://www.kumukahi.org/units/ka\\_honua/onaepuni/ahupuaa](http://www.kumukahi.org/units/ka_honua/onaepuni/ahupuaa)





# Nā Makani o Ni‘ihau-a-Kahelelani: Wind Names of Ni‘ihau, from Moses Kuaea Nakuina’s *The Wind Gourd of La‘amaomao*

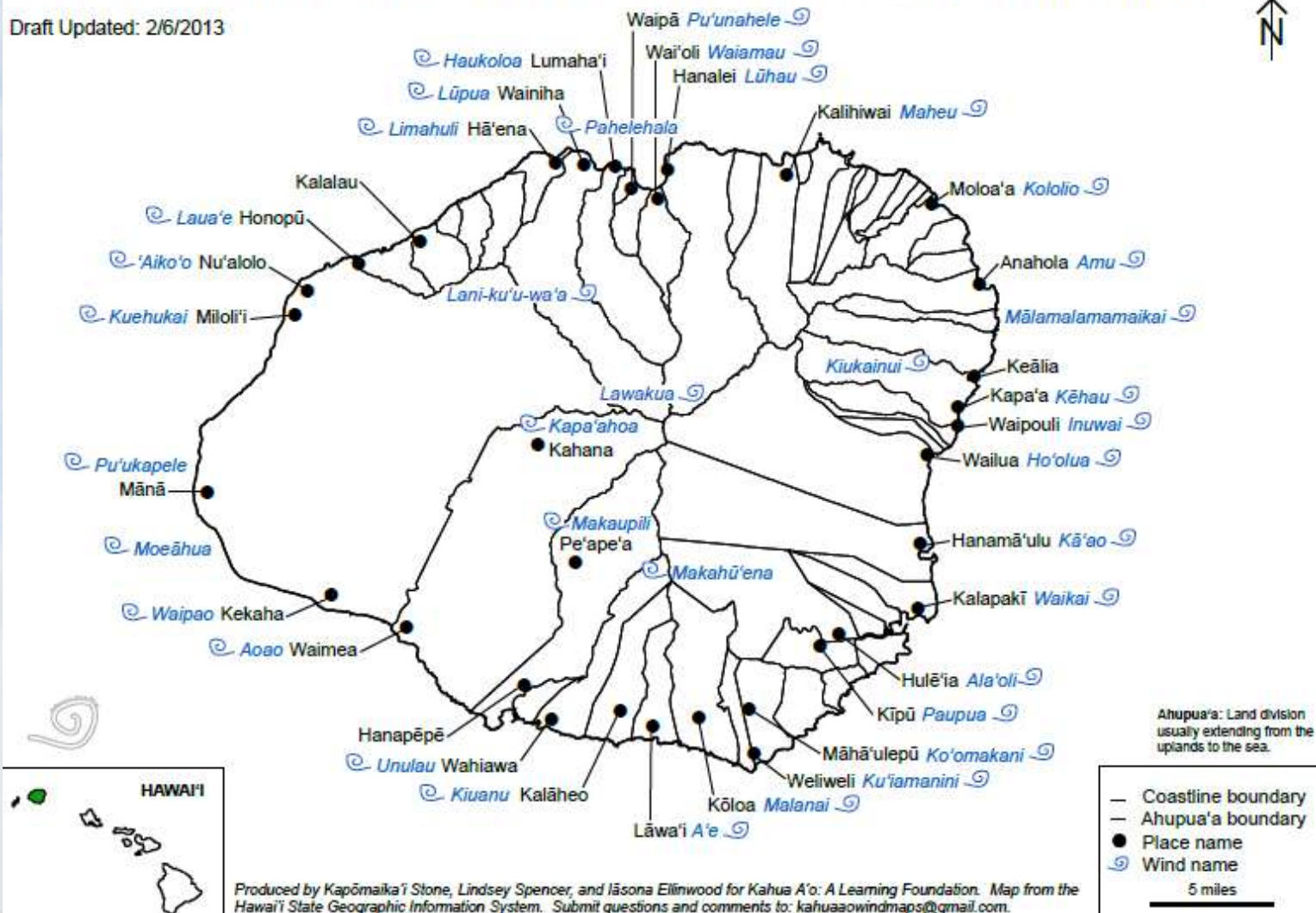
Draft Updated: 2/6/2013





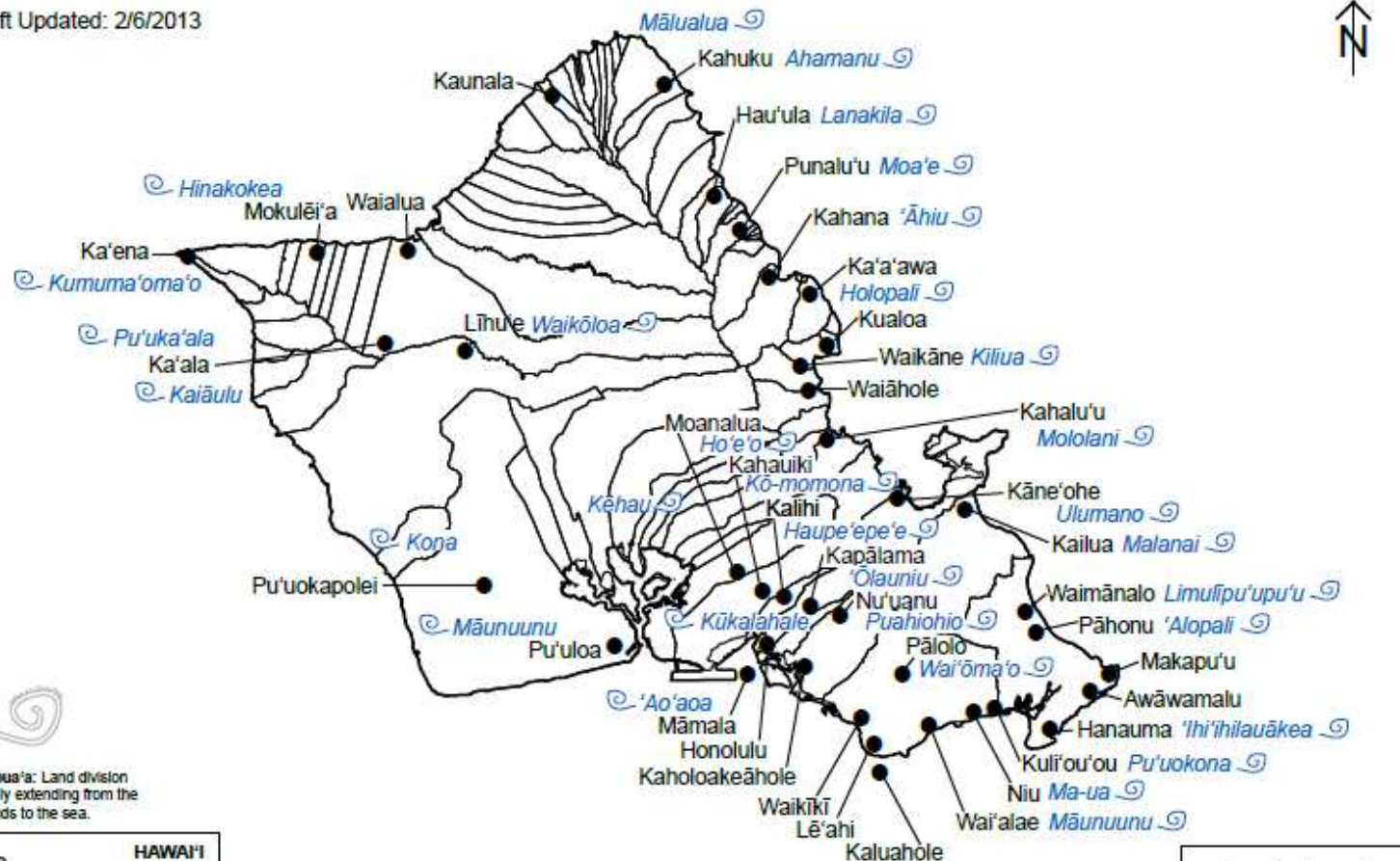
# Nā Makani o Kauaʻi-a-Mano: Wind Names of Kauaʻi, from Moses Kuaea Nakuina's *The Wind Gourd of La'amaomao*

Draft Updated: 2/6/2013



# Nā Makani o O'ahu-nui-a-Lua: Wind Names of O'ahu, from Moses Kuaea Nakuina's *The Wind Gourd of La'amaomao*

Draft Updated: 2/6/2013



**Māluualua** - sea wind that blows hard from the northeast

**Kuilua** – windward wind that churns up the sea

**'Ili'iliauākea** – wind that blows inside of Hanauma, wind from the mountain that darkens the sea and tosses the kappa of Paukua

**Limulipu'upu'u** - wind that comes ashore at Waimānalo

**'Ala'eli** - of Mānoa Valley

**Malailua** - strong, blustering wind at Nu'uānu



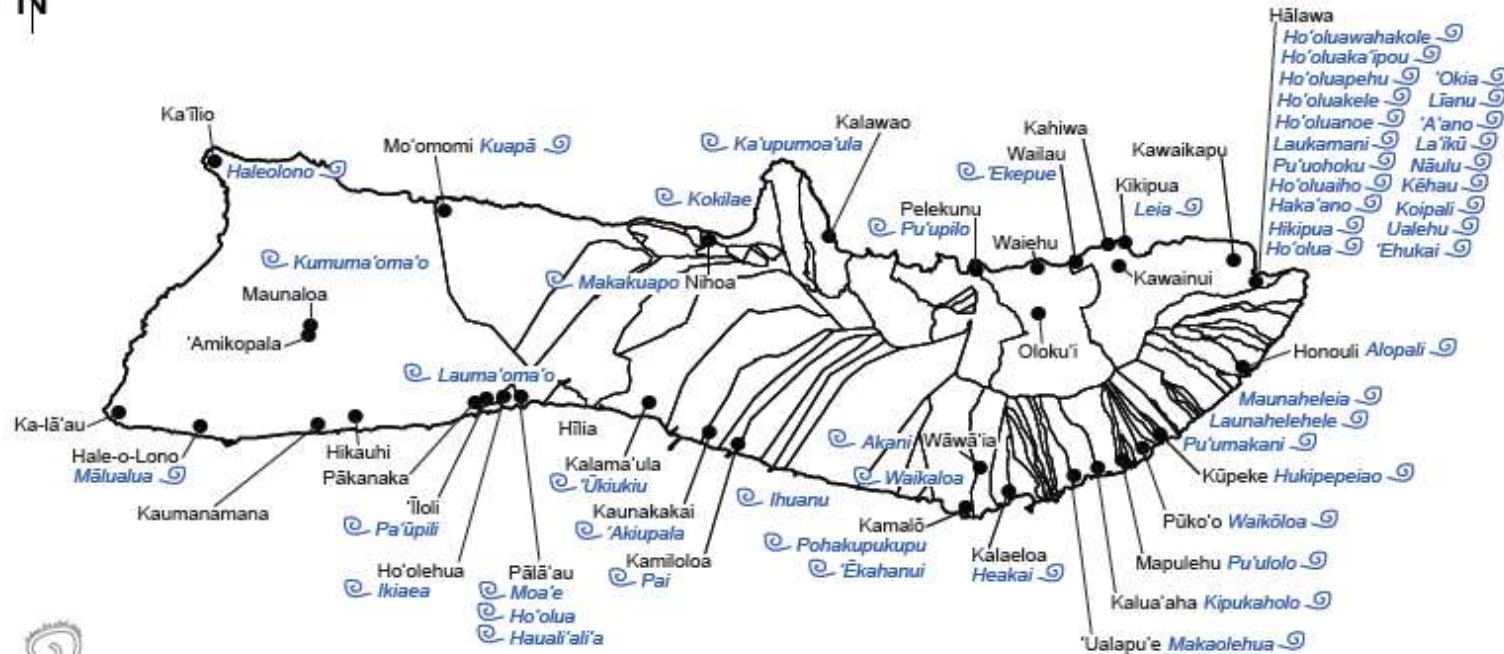
**Kumuma'oma'o** – of Kaluako'i, the Ho'olua in the forest, roaring wind of Kona and Ko'olau'

**Ūkiukiu** – of Kalama'ula that burns the 'ai of that hot plain

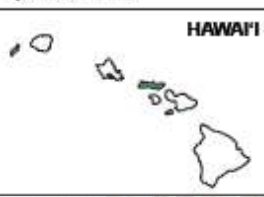
**Pa'ūpili** – brings calm to Īloli

## Nā Makani o Moloka'i-nui-a-Hina: Wind Names of Moloka'i, from Moses Kuaea Nakuina's *The Wind Gourd of La'amaomao*

Draft Updated: 2/6/2013



Ahupua'a: Land division usually extending from the uplands to the sea.



Produced by Kapōmaika'i Stone, Lindsey Spencer, and Iāsona Ellinwood for Kahua A'o: A Learning Foundation. Map from the Hawai'i State Geographic Information System. Submit questions and comments to: kahuaaowindmaps@gmail.com.

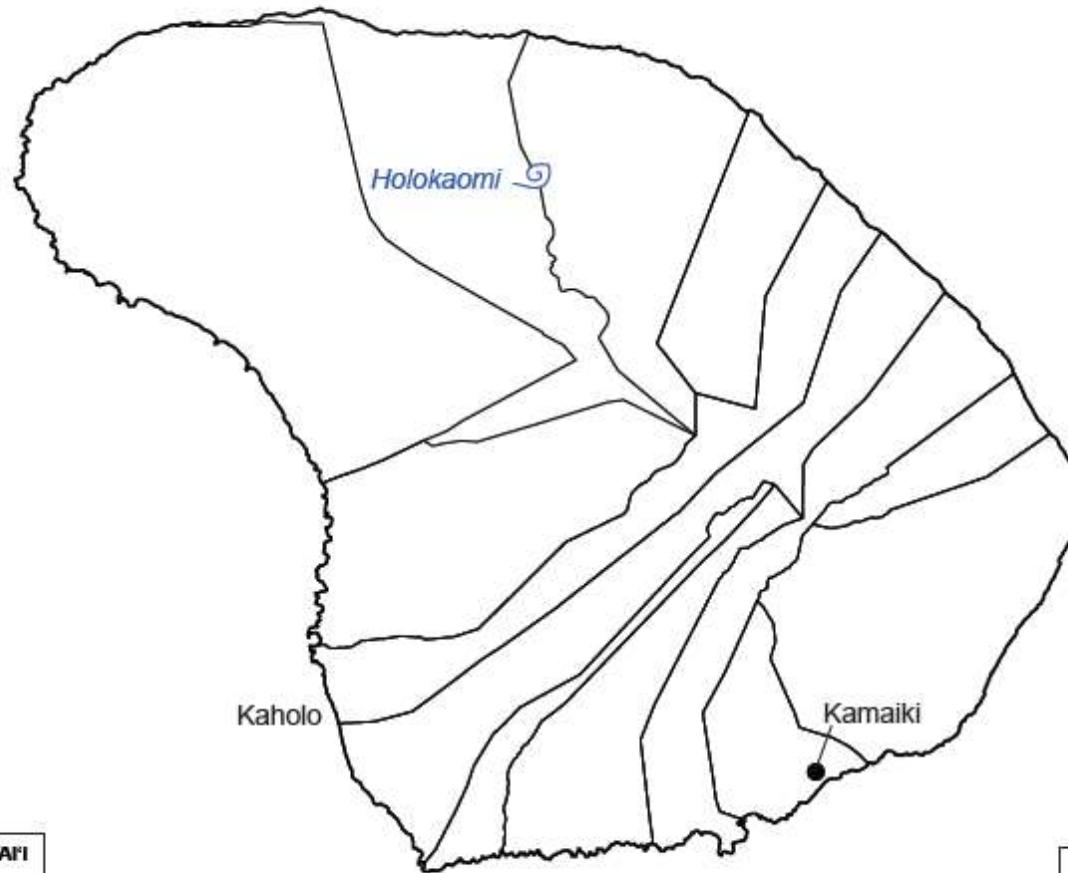
- Coastline boundary
- - Ahupua'a boundary
- Place name
- ☯ Wind name

3 miles



# Nā Makani o Lānaʻi-o-Kaululāʻau: Wind Names of Lānaʻi, from Moses Kuaea Nakuina's The Wind Gourd of Laʻamaomao

Draft Updated: 2/6/2013



Ahupua'a: Land division usually extending from the uplands to the sea.



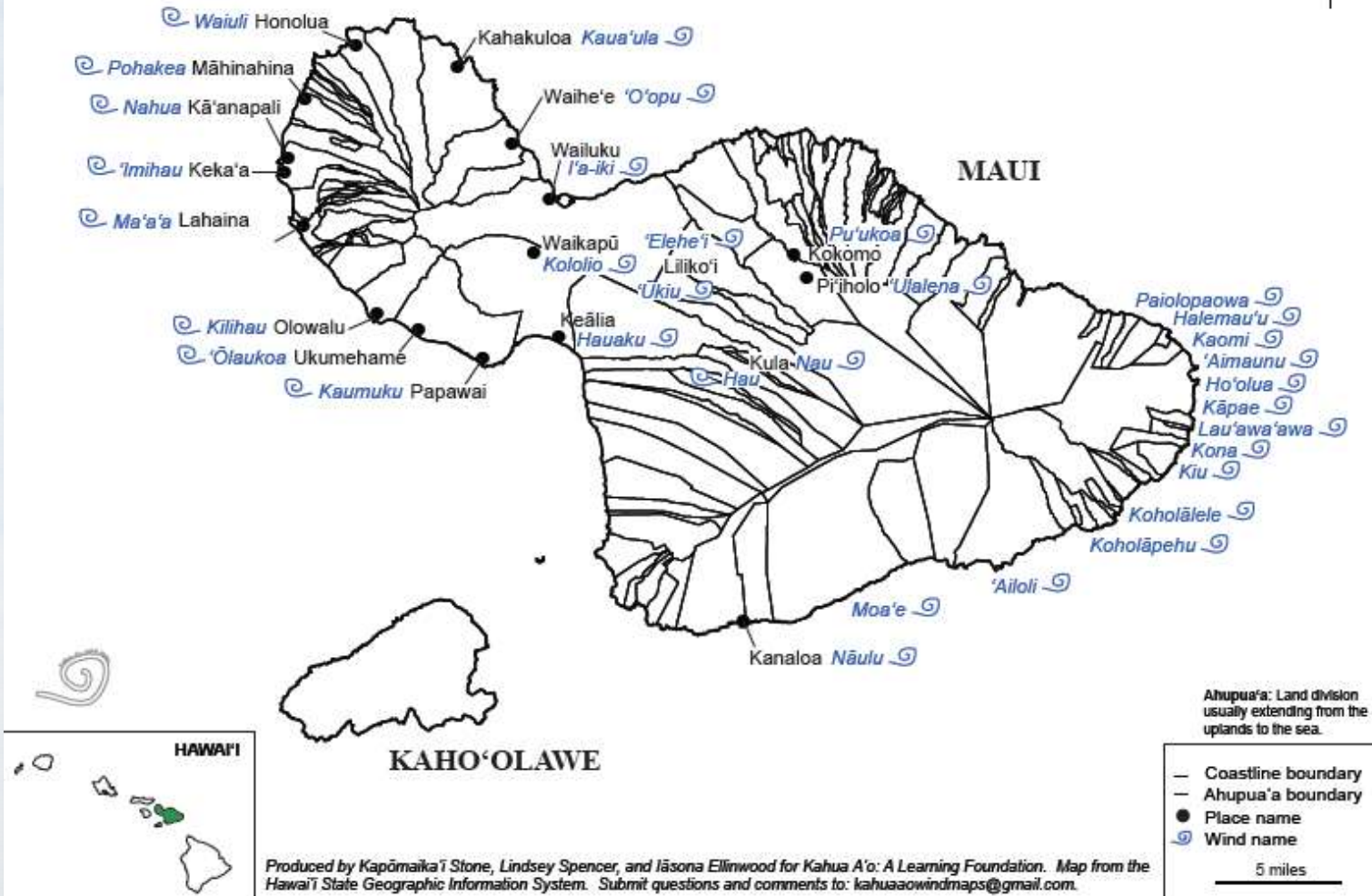
- Coastline boundary
- Ahupua'a boundary
- Place name
- ☯ Wind name

3 miles

Produced by Kapōmaikaʻi Stone, Lindsey Spencer, and Iāsona Ellinwood for Kahua A'o: A Learning Foundation. Map from the Hawaiʻi State Geographic Information System. Submit questions and comments to: [kahuaowindmaps@gmail.com](mailto:kahuaowindmaps@gmail.com).

# Nā Makani o Maui-nui-a-Kama: Wind Names of Maui, from Moses Kuaea Nakuina's *The Wind Gourd of La'amaomao*

Draft Updated: 2/6/2013



**'Olaukoa** – of Ukumehame that tears apart the hale at Olowalu

**Ma'a'a** – wind of Lahaina that settles at Kamaiki

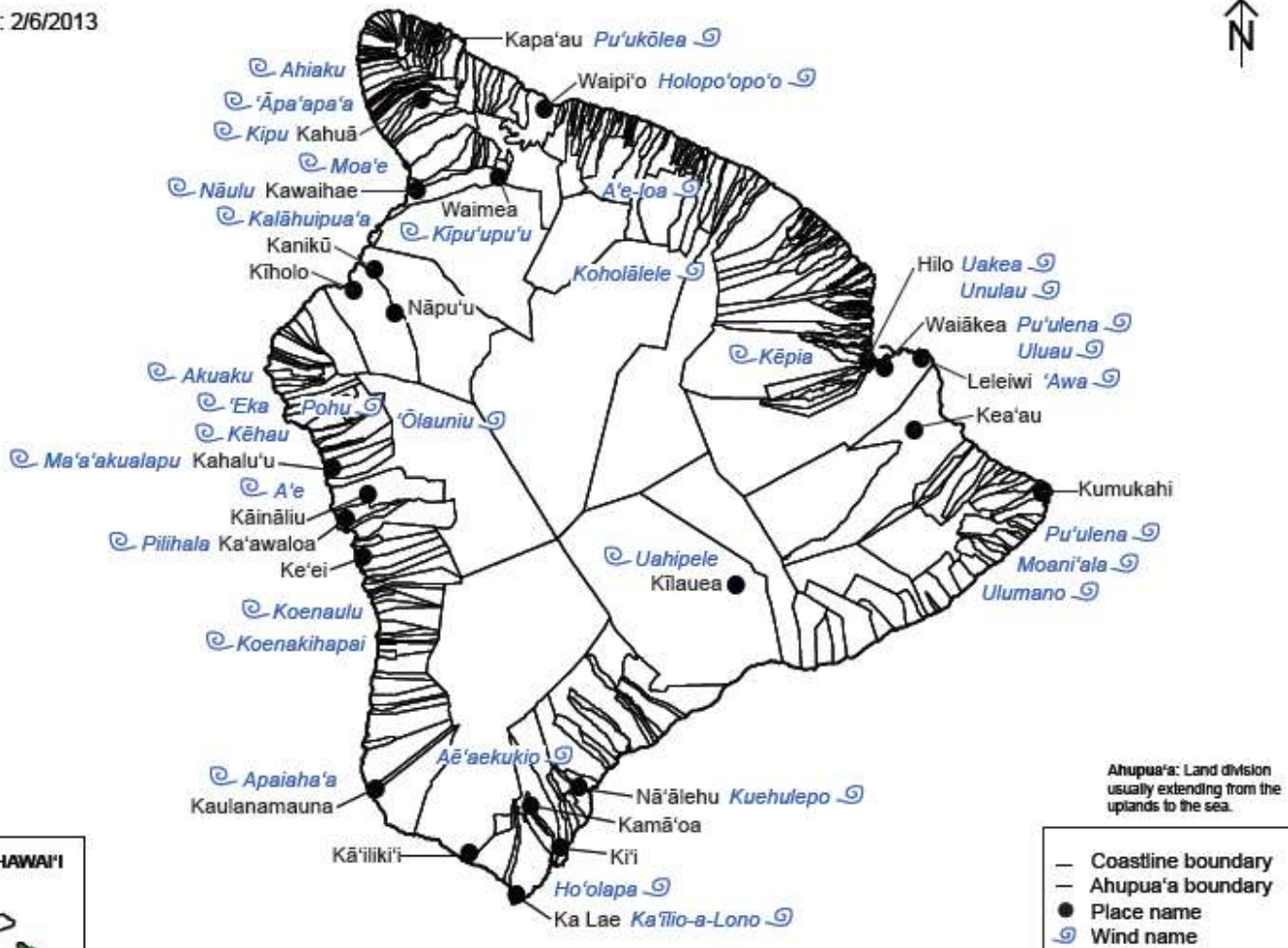
**'Imi-hau** - stormy wind at Lāhainā/Keka'a

**Kaua'ula** – wind that blows and roars up the cliffs of Kahakuloa and Waiuli at Honolulu

**Hau** – wind that descends from the uplands of Kula

# Nā Makani o Moku-o-Keawe: Wind Names of Hawai'i, from Moses Kuaea Nakuina's *The Wind Gourd of La'amaomao*

Draft Updated: 2/6/2013



Produced by Kapōmaika'i Stone, Lindsey Spencer, and Iāsona Ellinwood for Kahua A'o: A Learning Foundation. Map from the Hawai'i State Geographic Information System. Submit questions and comments to: kahuaaowindmaps@gmail.com.

**'Āpa'apa'a:** wind that flies about like vapor on Kohala upland cliffs

**Kīpu'upu'u:** cold wind of Waimea that hurts the skin

**Nāulu:** rainy wind of Kawaihae that comes and dashes the milo leaves of Makaopau Kipu: of Kahuā

**Moa'e:** wind of Kohalaiki that swells or gathers

**Ua Kea:** source of storms of Hilo, shearing off the edges of hale and breaking it up

**Moani:** light, gentle breeze usually associated with fragrance of Puna