

**Global climate change: winners and losers
e.g., a reverse-reaction cooling of
max summer temperatures in the
coastal SFBA & LA basins
during 1969-2005**

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Current Hypothesis

GLOBAL WARMING →
INCREASED INLAND TEMPS →
INCREASED TEMP GRADIENT →
INCREASED SEA BREEZES →
COASTAL-AREAS HAVE
COOLING SUMMER DAYTIME
MAX TEMPS

NOTE: NOT TOTALLY ORIGINAL
IDEA →

San Francisco Chronicle

How S.F. Could Get Even Foggier

'Greenhouse Effect' Could Backfire

By Charles Petit
Chronicle Science Writer

Notions that global warming from the "greenhouse effect" might bring balmy summers to San Francisco beaches got a dash of cold water this week.

A government oceanographer says a warmer Earth will make it even colder and foggier along Northern California's coast and that the trend may already have started here and in similar coastal regions in Spain, Morocco and Peru.

Hotter weather in the Central Valley might mean higher winds along the coast. The wind would stimulate upwelling of the cold water and onshore breezes that make the region's famous fogs, reports Andrew Bakun in today's issue of the Journal Science.

Bakun is a physical oceanographer and chief of the Pacific Fisheries Environmental Group, a 12-person research laboratory operated by the National Oceanic and Atmospheric Administration in Monterey.

In an interview, Bakun emphasized that his projection cannot calculate just how much foggier it may get. He also said he could easily turn out to be wrong — just as widely accepted predictions that the Earth on average will warm by 3 to 9 degrees Fahrenheit in the next century may also turn out wrong.

But, he said, the main point is that even if the greenhouse scenario is correct for the planet on average, "it is a mistake to think that means it will warm up everywhere. There are very good reasons to think it will be colder here, at least in summer."

He also suspects that the summer fog season would start earlier in the season and end later.

Summer fog streams regularly across California's coast, most intensely between Point Conception

WHY 'GREENHOUSE EFFECT' MAY MEAN MORE COASTAL FOG

Heat in the Central Valley creates a weather cycle that promotes fog along the coast, which drifts inland and cools things down. If the "greenhouse effect" makes the Central Valley hotter, the whole process could produce more fog.

- 1 Heat in the Central Valley creates a low pressure area in the atmosphere. Winds move around the low counter-clockwise.
- 2 The wind pushes surface water south along the coast. The currents eventually veer away from land in a process called the Ekman transport.
- 3 As the surface water works out to sea, cold water wells up from the ocean floor.
- 4 The shore winds, moving inland over hills and valleys along the coast, carry moist warm air over the frigid coastal upwelling to form fog.

Source: National Oceanic and Atmospheric Administration

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northward to Oregon, because of several factors.

The chief ones are upwellings of deep, cold ocean water to the surface along the shore and breezes that draw relatively warm, humid air inland. The combination of chilling from the upwelling water, and land that forces the air upward, causes fog to condense from the air.

Although measurements are not precise, data suggest that winds have already started picking up along California's coast. Studies of wind stress — the amount that winds push surface currents — show a roughly upward trend since about 1945. This is during a time that some climatologists believe they have detected a slight warming of the Earth. Similar trends appear under way off the coasts of Peru, Spain and Morocco where local fog conditions resemble those of Northern California.

Upwelling causes both the frigid swimming conditions along Northern California's beaches, as well as the good fishing. The deep waters carry nutrients that support much of the shallow marine life of California.

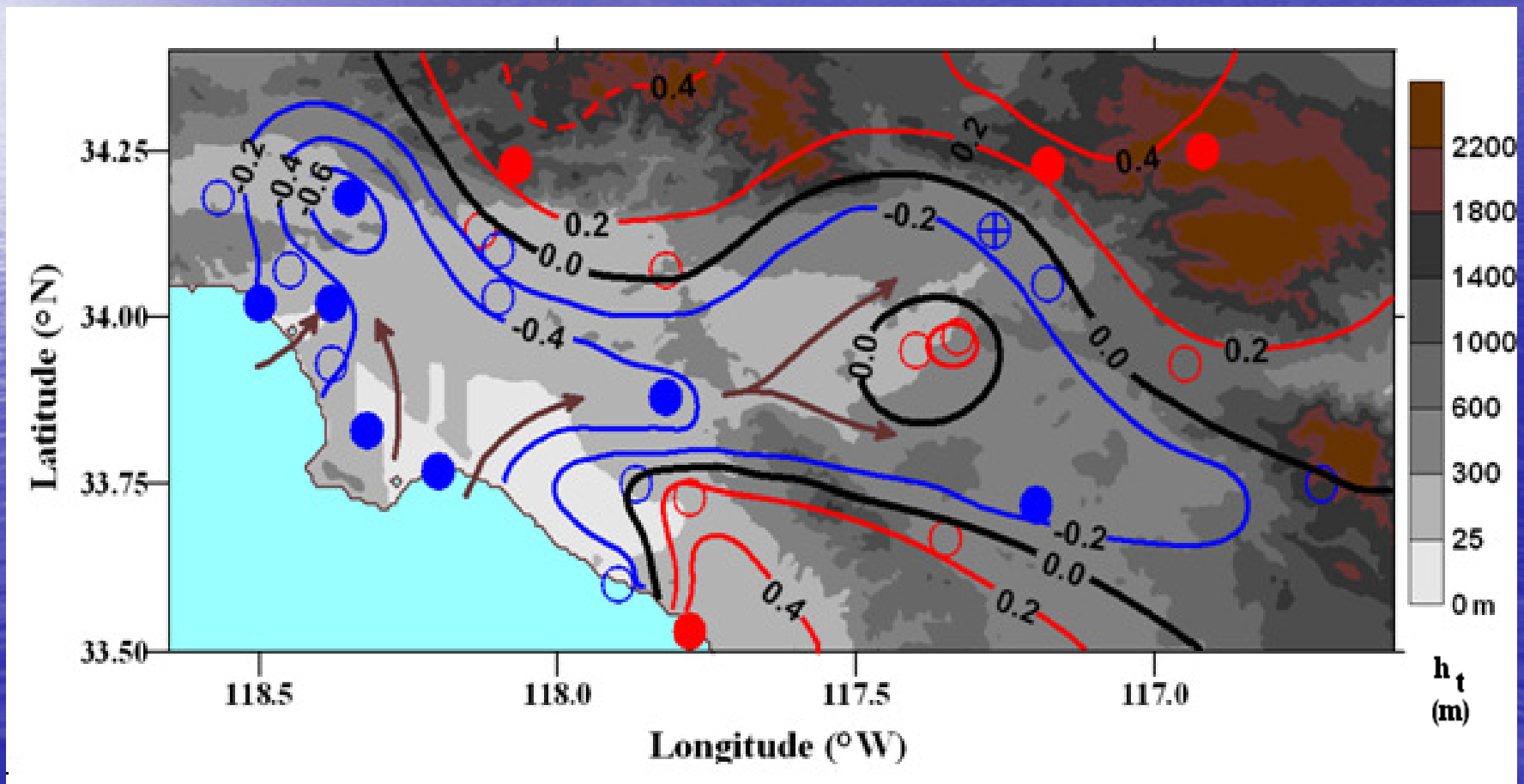
A fisheries specialists, Bakun not sure that more intense upwelling would improve fishing. "It would be more nutrients, but it will also have more rapid export of these nutrients offshore, and wind means more turbulence."

Lebassi et al. (2009) J. of Climate

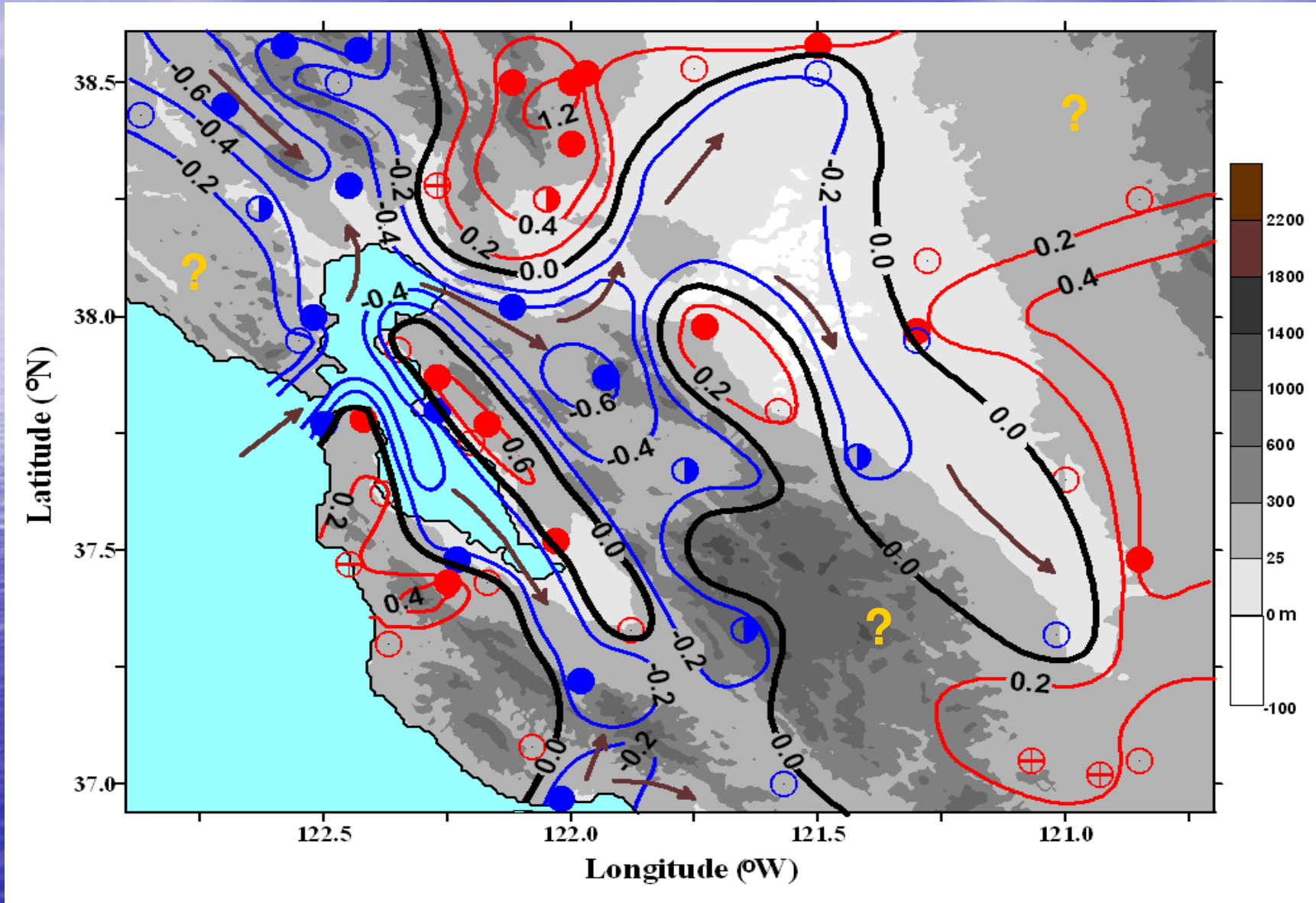
Observed 1970-2005 LA Average Summer Daily max-Temp ($^{\circ}\text{C}/\text{decade}$) trends show concurrent:

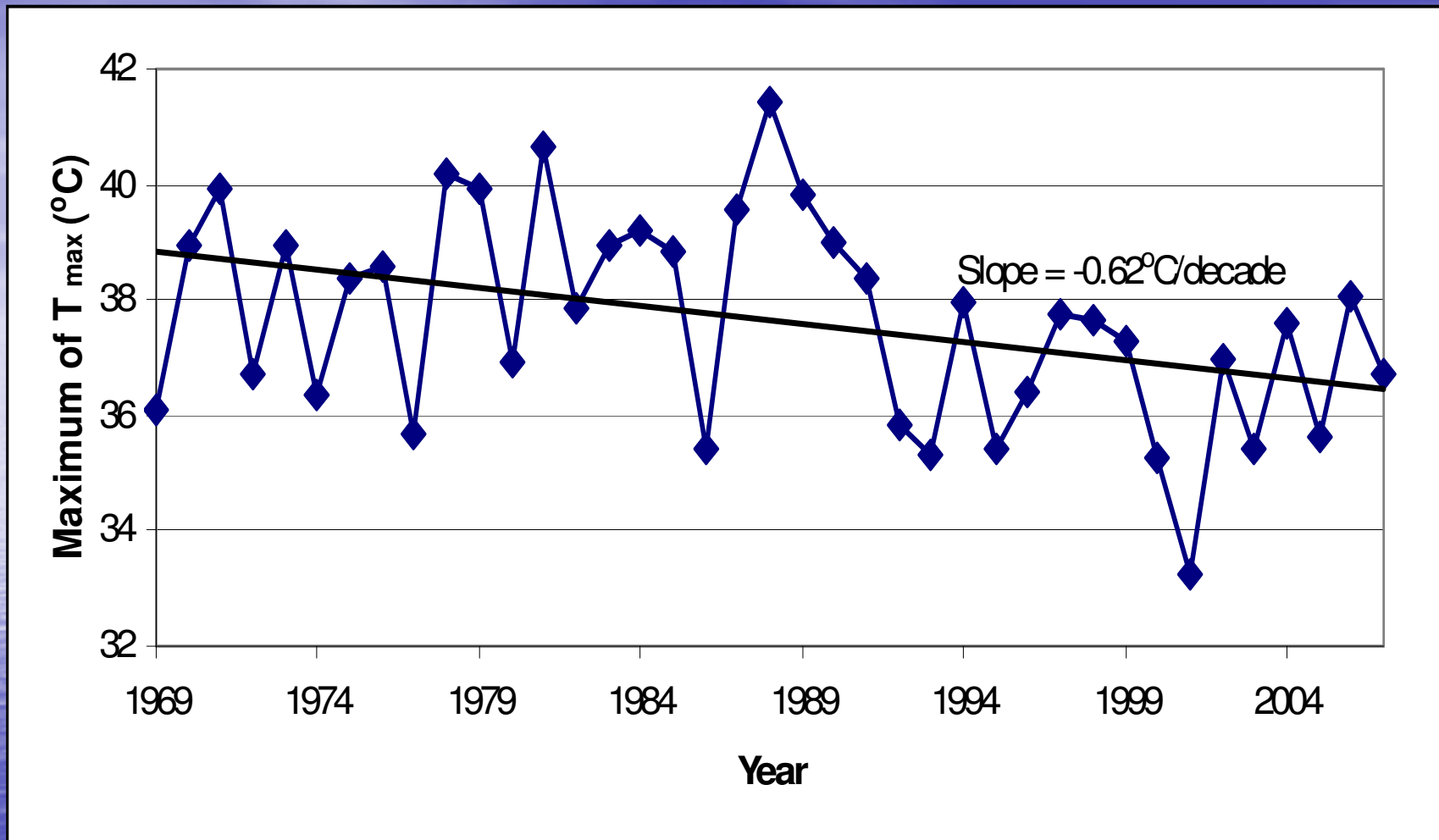
> low-elev coastal-cooling & > high elev & inland-warming

Arrows = mean air-flow



SFBA & Central Valley 1970-2005 Average Summer Daily Max-Temp warming/cooling trends ($^{\circ}\text{C}/\text{decade}$), as in previous figure





Time-series of 1969-2007

Annual max-temp (extreme events)

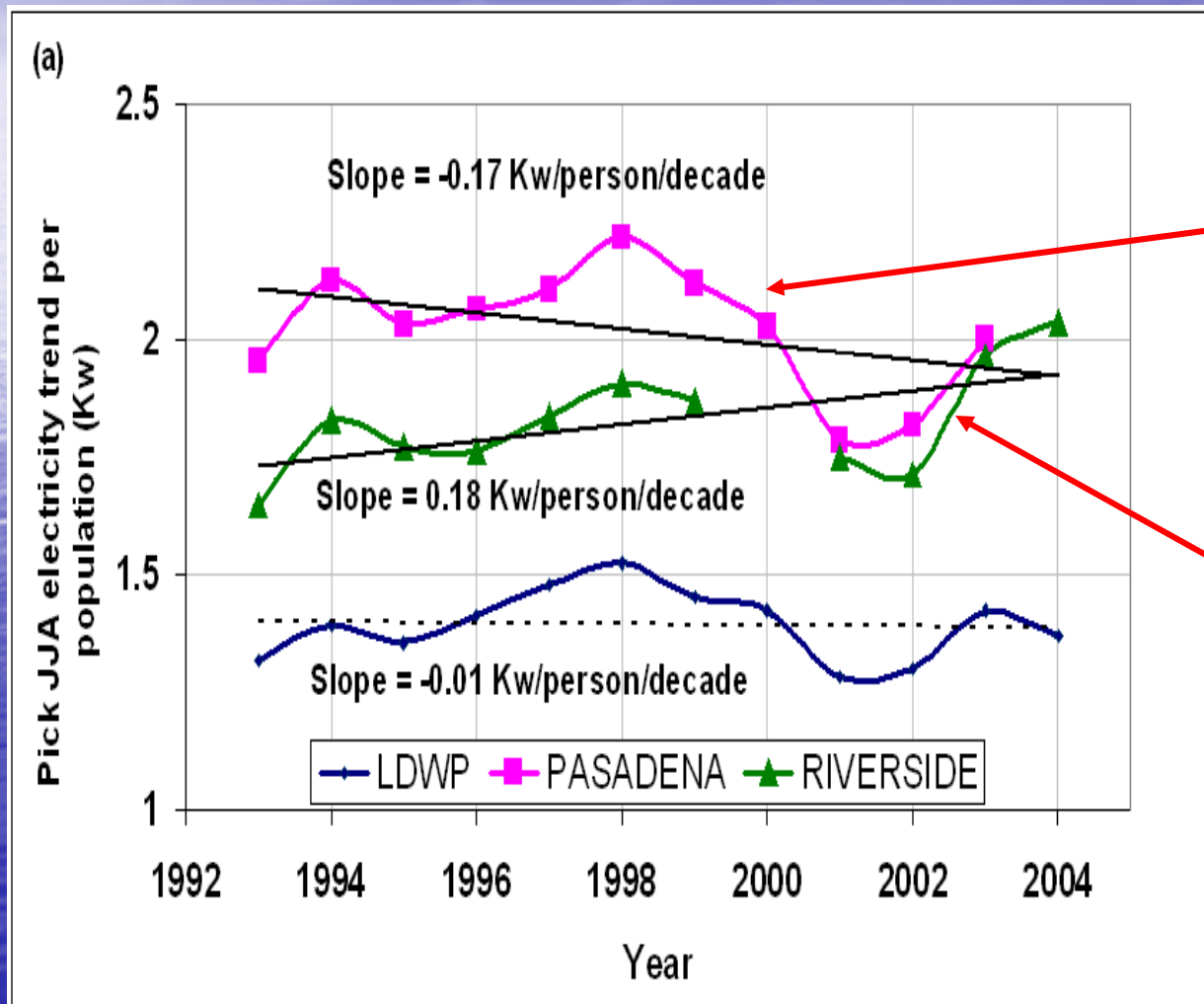
- Results: decreasing-values (-6.2 K/100-yr)

Peak Summer Electricity-Trends for 1993-2004 in (KW/person/decade)

Lebassi et al. (2010) J. of Solar Energy Engineering

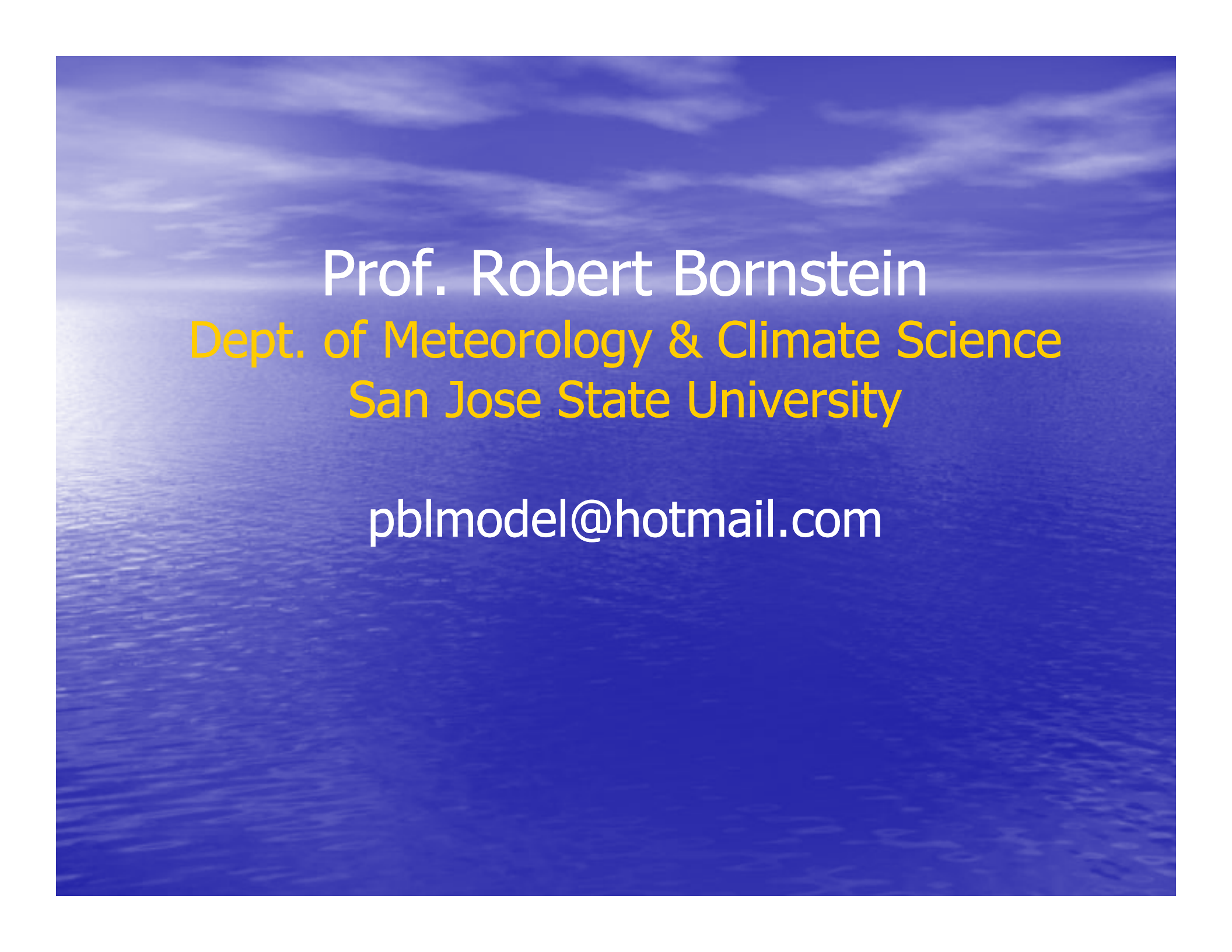
Results show:

- Coastal-cooling
Pasadena:
downward trend
(-8.5%/decade)
- Inland-warming
Riverside:
upward trend
(+11%/decade)



Summary of Results

- **Global-warming resulted in a local sea-breeze induced “reverse-reaction” coastal-cooling of summer**
 - > **average** max-Temp's by -3°C /100-years
 - > **extreme** max-Temp 's by -6°C /100-years
- **Implications from coastal-cooling:** lower “peaks” of
 - > energy-use for cooling
 - > heat-stress levels
 - > peak O_3 concentrations
- **Global climate-change will produce:**
 - > **many** losers
 - > **some** “partial” winners, e.g., coastal-cooling, but also coastal-flooding & reduced water-supply



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