The Long Range Eye of Jerry Namias

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Namias' very early perceptions of the interactive role of the atmosphere with its lower boundary in shaping future events deserve special attention. Anomalous sea-surface temperature, soil moisture and snow cover "feed-backs" provided a long term "memory" to the atmosphere, not only locally, but also remotely through "teleconnections". So what's new?

Personal Antecedents

As I recall it, I first became aware of Namias in 1943, when I was an Air Corps meteorology cadet at MIT. It was references in the AMS monograph on air-mass and isentropic analysis, published in 1940 [1], that attracted my attention. At this tender point in my own beginning career, Jerry was already an established figure in the literature.

But it wasn't until 1947 (in August) that I first actually met him. It was at a picnic of his Extended Forecast Section of the Weather Bureau (Figure 1). I was accompanying my bride-to-be. At the time, I was a kid of 23 and he was a middle-aged man of 37. Well, Jerry is still a middle-aged man, but the rest of us have gotten a lot older.

In June 1948, I joined the Weather Bureau as a very junior employee and thereupon began my long professional relationship with Jerome Namias.

My Goal Today

When I was invited to help celebrate Jerry's diamond birthday, many things ran through my mind. Where does one start in paying tribute to his extraordinary talents? There is so much that I have admired and there is so much that our science and profession owe him.

Of all that one can say, I have decided to try to exemplify his contributions by a brief analysis of his early track record on the interactive influence of the atmosphere's lower boundary on its longer-term behavior.

Namias was so far ahead of his time, empirically, conceptually and semantically, that most of his ideas were not immediately picked up, but had to be rediscovered some years later.

To accomplish my task, I have gone to Namias' 3 volumes of Collected Works. (I guess it's still only three volumes.) As it turns out, to make my point, I need only refer to little more than a dozen of his papers published between 1948 and 1963. My problem was to keep my eye on my single-minded objective, and not wander off into so many of the other things that he has written between 1934 and this morning. Of course, I will be making quotations from Namias' white book.

Figure 1. *August, 1947 picnic. P. Clapp, H. Wexler, J. Namias and J. Smagorinsky, left to right.*

Precedents

Before 1948, Namias concerned himself with a variety of atmospheric properties and phenomena newly revealed by the aerological network. This ranged from the dissipation of tall cumulus clouds, to subsidence and to the jet stream. He recognized the power of isentropic analysis as a diagnostic tool for the study of the larger scale motions of the atmosphere, and already showed a curiosity about fluctuations in characteristics of the general circulation, no doubt influenced by Rossby. In particular, Namias wrote several papers having to do with changes in the intensity of the westerlies and the development and propagation of long waves. In the latter 40s, he began to consider longer period phenomenology: such as normal fields of convergence and divergence, and the abnormal winter of 1946-47. This is where we pick him up.

Starting with 1948

In 1948, Namias published a paper [2] in the Transactions of the American Geophysical Union entitled "Evolution of monthly mean circulation and weather patterns". It was an attempt to summarize some main conclusions drawn from 6 years of experience in the preparation of monthly mean forecasts:

"(1) that regardless of how they are made up, monthly mean charts, particularly those constructed for mid-tropospheric levels, to a large extent determine monthly mean temperature and precipitation anomalies; and

(2) monthly mean mid-troposphere flow patterns of the general circulation, when

treated on a hemisphere-wide scale, undergo an orderly evolution and development which can be rationalized at least qualitatively by use of physical and kinematical principles."

The interpretation and value of monthly mean maps was very controversial at the time, and I think there still are some skeptics today. But the second conclusion is the one I want to dwell on. Namias was not only an extraordinary and consummate observer of nature, perceiving order where most others could see only chaos, but also he hardly ever hesitated to interpret what he saw. He was, and still is, the quickest gun in town to offer a hypothesis. In this case he offered three, which he attributed to predecessors in the foregoing century. He suggested that the original large-scale disturbances may be due to:

"(1) Extraterrestrial influences upon the Earth's upper atmosphere, particularly the effect of variations in the energy of selected bands of the Sun's spectral radiation on the atmosphere's ozone layer.

(2) Terrestrial influences, particularly variations in snow cover and temperature of ocean currents.

(3) Variations in the character and amount of nuclei of condensation and/or other atmospheric suspensoids."

As far as I know, this was Namias' first mention of possible effects (though not yet interactions) of snow cover and sea surface temperature. He dropped the idea of condensation nuclei or suspensoids in later papers, but he hung on to the possible influence of solar variations for surprisingly long, as we shall see.

In a subsequent paper in 1950 [3] on the role of the index cycle in the general circulation, Namias marveled at the coherence of this atmospheric phenomenon for intervals ranging from four to six weeks, but confessed "that its usefulness in the practice of extended forecasting has been somewhat disappointing". Nevertheless, in recognition of it's symptomatic significance, he set out to comment on three characteristics of the index cycle (and I paraphrase):

(1) The main poleward heat transfer occurs sporadically, at least once a year, during the low index, blocking phase of the cycle.

(2) Interannual variations in the intensity of the index cycle are connected with varying locations of the "quasi-permanent anchor troughs and ridges of [the] mid-troposphere" in different years; "it is quite possible that lag effects of ocean currents, snow cover, etc., are dominant factors".

(3) There appears to be one particular period (in late February) when the most pronounced cycle appears. The two essential ingredients, an extensive cold [polar] reservoir [providing maximum available potential energy for baroclinic instability] and Atlantic blocking are both favored at this time of the year.

Although these were offered as explanations, only the second one, on interannual variability, qualifies as such. And this is a reassertion of a rationale that was to develop over the years in Namias' line of thinking and personal research.

In the following year, Namias undertook a study of the winter of 1949-50 [4]; and, as usual, his main tools were the time mean 5, 15 and 30-day surface and 700 mb geopotential maps. He was ready to more firmly offer a hypothesis for the long life of a "vast warm anticyclone [which] moves in a great arc from the southeast Pacific into the Bering Sea and Canadian Yukon" and its influence on "Pacific storm tracks and anomalies over the United States". Shades of the PNA!

In this paper he referred to Rossby in declaring that "once one large-scale feature of the general circulation is established, it attempts to mold other features of the circulation in far distant areas, largely through the flux of vorticity". But then Namias went on with what must be his own intuitive idea. It is typical of his ability to reason non-linearly, as if he were an intimate part of the system itself, but willing to reveal its secrets. And I quote:

"But this attempt may conflict with or be reinforced by the effects of differential heating. The final state of the mean circulation for a period of, let us say, a month is the result of the interplay between differential heating and mutual dynamic interactions of the components of the great mid-tropospheric wave patterns. Thus, differential heating may operate on a given initial state to encourage one flow-pattern, but that pattern is rearranged through mutual interactions of troughs and ridges into a more harmonious and stable assemblage of component parts." And so colorfully said!

In 1952, he wrote on the annual course of month-to-month persistence [5], and it is sufficient to directly quote his concluding paragraph:

"An analysis of the year-to-year behavior of persistence suggests possible secular variations most pronounced in winter and spring with possible oscillations of the order of a decade. While the data are insufficient to test a possible solar cause of these secular variations, at least they are not easily related to solar variations. The long-period variations in persistence of contour patterns during cold seasons appear to be related to the mid-tropospheric zonal index in the sense that greater persistence accompanies low index. This relationship may suggest self-perpetuating controls operating preferentially during [the] sluggish air flow period through earth-bound conservatizing factors like snow cover, soil moisture, and ocean temperature."

There, he said it! A little obscured by his characteristic picturesque language but, nevertheless, he said it.

In 1954, in a paper published in the Bulletin of the AMS [6], Namias still puzzled over "what determines the positions and intensities of the centers of actions both in their normal and abnormal states." He restated his inclination "to join the 'old fashioned' school of meteorologists which believes that abnormal circulations may bring about abnormal conditions at the surface (e.g., snow cover, ocean temperatures, etc.) which may substantially play a regulatory role in determining atmospheric circulations."

In the same year, he wrote the first in a series of papers [7] tying genesis and paths of tropical cyclones to larger-scale longer-term fluctuations of the general circulation and climate.

In a 1955 MWR paper on drought [8], Namias repeated that persistent anomalies could be influenced by "the differing effect of various surfaces (snow cover, open water, bare land, etc.)", and attributed the possibility of extraterrestrial causes to "another school of thought". So he finally got it out of his system.

He also mentioned in passing "the impact upon various air flows of mountain chains". I doubt whether Namias foresaw the orographic implications on multiple-equilibria. However, I do feel that he understood early-on that certain, more persistent states, were inherently more predictable than were the more volatile transitions. The main question unanswered at this point was the reason why. Was it primarily the result of non-linearities of the atmosphere-lower boundary system or could it be explained entirely in terms of non-linearities within the atmosphere itself?

But even today, the last county has still to be heard from. It may very well be that both types of non-linearity are important, probably depending on the time scale of variability.

We now skip to 1958 [9], when Namias pointed out that interrelations between the subpolar cyclonic centers of action and the subtropical anticyclones were already known by Walker in 1930. Namias suggested that such sea-saw "interconnections [he hadn't yet used 'teleconnections'] and many others of a regional nature often are associated with 'index cycles' which last from 3 to 6 weeks".

But "while the index cycles ..are primarily cold season phenomena, there are apparently great and persistent abnormalitites of the hemispheric circulation which also occur in summer. One of these aberrations which has strong influence on the seasonal characteristics of much of the Northern Hemisphere occurs when a girdle of persistent positive anomalies appears in mid-latitudes, and is generally associated with a northward displacement of the subtropical anticyclones." He then referred to a year-earlier paper where he suggested that there may be a connection between summers characterized by circulations of this anomalous type and the adjacent winters.

We now come to Namias' first published attempt to document relationships between North Pacific waters and the overlying (not remote) atmospheric circulation. It was in a 1959 paper in the JGR [10]. That study, confined to the Pacific basin north of 20 deg latitude, described conditions from the summer of 1957 through the spring of 1958. Namias found that anomalous warming of the surface waters of the eastern North Pacific was related to prevailing abnormalities in the overlying circulation. He ascribed the long-period continuity to a "feedback" (his terminology) "between ocean and atmosphere against the slowly changing climatological background." Changes in surface wind were considered to be a decisive interactive factor on ocean surface temperature.

Of course, all of these papers had a great deal of detail in them, both in the empirical evidence offered and in the development of his arguments and explanations. Many of his hypotheses and conclusions were reasserted in his prolific productivity. But one can see how a highly intuitive early hunch came back more than once to be restated and reenforced with more data, though not always convincing to his contemporaries. For example, in still another paper on persistence in 1959 [11], Namias concludes "evidence seems to be accumulating that in seeking the reason for long-period persistence, one must not only examine further anomalous surface conditions, perhaps brought about by preceding circulations and weather, but also the inherent hydrodynamic stability of different mean flow patterns at certain times of the year." Would he have felt at home with the notion of multiple-equilibria if it had been known then?

For a conference on numerical weather prediction in Tokyo in 1960, Namias prepared a paper [12] entitled "Influences of abnormal surface heat sources and sinks on atmospheric behavior". And it was abnormal behavior that Namias was concerned with. He tried to give specific examples of evidence of the influences of variable sea surface temperature, soil conditions and snow cover back on the overlying atmosphere as well as remotely. The latter spatial interdependence he termed "teleconnection". It is the first reference to the term in Namias' papers, but I am not certain whether it was original with him.

By 1963, Namias was beginning to openly admit his full appreciation for the utter complexity of the nature of large-scale air-sea interactions. In a JGR paper [13] he notes: "The feedbacks envisioned are not simple cause and effect relationships but are complexly coupled mechanisms established by the eternal abnormailty of the large-

scale states of both atmosphere and sea. This type of interaction renders futile any attempt to discover an 'ultimate cause' of climatic anomalies in air or sea, because one abnormal state in either medium leads to abnormalities in the other, and the longevity of the disturbed condition differs between atmosphere and ocean." And that's Namias' way of expressing the notion of fast and slow manifolds.

These extraordinary insights suffered one essential flaw: Namias' maps stopped at 20 deg north latitude. However, in another paper later that year in the MWR [14], Namias set out to see if he could relate events in the two hemispheres. With a knowledge of Walker's earlier work on the Southern Oscillation, he reasoned that regional (that is, longitudinal) variations in the position of the Hadley cell (that is, the Walker circulations) would be the agent for coupling the displacements of planetary waves in temperate latitudes.

At this point we can say with 40/40 hindsight that Namias failed to appreciate the possible role of the equatorial oceans. Namely that the coupling of the atmosphere and oceans in the equatorial tropics was singular, in that the reaction time of the ocean was very short because it was highly stratified, and the reaction of the atmosphere was very deep because of the dominance of convection. The net result was a much shorter time scale and a much more direct interaction between atmosphere and ocean than elsewhere.

This, as we now know, is still not the whole story, but it no doubt is an essential chapter. However, it is also becoming clear that the extra-equatorial chain of events in the atmosphere and oceans over intervals of seasons to years cannot be understood with the tropics excised. It took another remarkable observer of nature to fill that gap in the latter 1960s, Jacob Bjerknes. I have never looked upon Namias and Bjerknes as competitors. Rather the extraordinary clarity with which they each viewed rather limited observational data in both media, together have contributed to stimulating a whole new and exciting era of scientific inquiry on a subject of enormous intellectual and practical importance. It is indisputable that Namias and Bjerknes are two of the few intuitive giants in our field this century.

I guess the question that is left begging is just what is the role of the extra-equatorial oceans? And to that Jerry would probably say: WHAT??!! We know that normally the oceans greatly influence the atmosphere off east coasts in winter during cold outbreaks, when convection over the warm coastal currents carries the heat deeply into the atmosphere. Also, rather pronounced low level air-mass modification normally occurs as a result of upwelling along west-coasts. But what about the influence of atmosphere on the ocean? Are Namias' empirical large-scale findings a reflection of secondary interactions in the extra-tropical latitudes? They certainly cannot be ignored.

At this point it is appropriate to quote the last paragraph of one of the last papers [15] of the first volume of Namias' Collected Works, also dated 1963. It sums things up quite well at that point in Namias' history:

"...some influences external to the atmosphere must be called upon to provide a 'memory' in order to cause the persistence and persistent recurrence. These influences might well be provided by abnormalities in the surface both at sea and on land...; abnormalities created in the first place by circulations which remain anomalous in the same sense over intervals at least a season in length. The author hopes to throw further light on this special case by more exhaustive study." And, as we know, that he did!

Postscript

I just note the following in passing. Upon examining the current menu of key subjects of the World Climate Research Program, see how quickly you recognize some of Jerry's adolescent playthings: seasonal to interannual prediction; the role of the oceans in climate variability; land-surface processes including the ground hydrology; the cryosphere and its interactions with the climate system.

It's tempting to continue to track Jerome Namias' ideas and findings to more recent times. I'm sure that others today will uncover many other facets. My object was to show how early on it was that Jerry appreciated the importance and the nuances of many of the basic ideas that have made interannual variability one of today's hottest research topics in meteorology and oceanography. And, in the process, he also greatly enriched our vernacular.

I have always considered it a privilege to have been Jerry's friend and colleague. I am grateful to our hosts for inviting me to participate in this party.

[1] 1940: *An introduction to the study of air-mass and isentropic analysis*, 5th edition (revised and enlarged), Ed. Robert G. Stone, October 1940, American Meteorological Society, Boston, MA, 232 pp.

[2] 1948: Evolution of monthly mean circulation and weather patterns. *Transactions American Geophysical Union*, **29**, 777-788.

[3] 1950: The index cycle and its role in the general circulation. *Journal of Meteorology*, **7**, 130-139.

[4] 1951: The great Pacific anticyclone of winter 1949-1950: a case study in the evolution of climatic anomalies. *Journal of Meteorology*, **8**, 251-261.

[5] 1952: The annual course of month-to-month persistence in climatic anomalies. *Bulletin of the American Meteorological Society*, **33**, 279-285.

[6] 1954: Further aspects of month-to-month persistence in the mid-troposphere. *Bulletin of the American Meteorological Society*, **35**, 112-117.

[7] 1954: Long-range factors affecting the genesis and paths of tropical cyclones. *Proceedings of the Unesco Symposium on Typhoons*, 213-219.

[8] 1955: Some meteorological aspects of drought with special reference to the summers of 1952-54 over the United States. *Mon. Wea. Rev.*, **83**, 199-205.

[9] 1958: The general circulation of the lower troposphere over Arctic regions and its relation to the circulation elsewhere. *Polar Atmosphere Symposium, Part 1, Meteorology Section*, Pergamon Press, London, 45-61.

[10] 1959: Recent seasonal interactions between North Pacific waters and the overlying atmospheric circulation. *J. Geophys. Res.*, **64**, 631-646.

[11] 1959: Persistence in mid-tropospheric circulations between adjacent months and seasons. *Rossby Memorial Volume*, Oxford University Press, NY, 240-248.

[12] 1962: Influences of abnormal surface heat sources and sinks on atmospheric behavior. *The Proceedings of the International Symposium on Numerical Weather Prediction*, Tokyo, Nov. 7-13, 1960, Meteorological Society of Japan, 615-627.

[13] 1963: Large-scale air-sea interactions over the North Pacific from summer 1962 through the subsequent winter. *J. Geophys. Res.*, **68**, 6171-6186.

[14] 1963: Interactions of circulation and weather between hemispheres. *Mon. Wea. Rev.*, **91**, 482-486.

[15] 1963: Surface-atmosphere interactions as fundamental causes of drought and other climate fluctuations. *Proceedings of Rome Symposium on Changes of Climate*, Arid Zone Research XX, Unesco and WMO, 345-359.