INTERVIEW OF
DR. MICHAEL HESSE

Conducted by Troy Cline

DR. HESSE: Sure. My name is Michael Hesse. I'm a Director of the Heliophysics Science Division here at NASA's Goddard Space Flight Center, where I have the pleasure to work with 300 highly talented individuals on the science of the sun and its interaction with the interplanetary medium and the magnetic and electric fields of the planets, and that includes space weather.

DR. HESSE: Okay. So what are my primary research interests and what do I like most about it? Well, I'm a -- I'm what I call a space plasma physicist, so I'm interested in fundamental processes in space that essentially determine how space works, how charged particles in electromagnetic fields interact in space. Now, I like that for two reasons, and the first is that it is simply scientifically challenging. It's basic science applied to a medium that we, as humankind, have a great interest in. There's interesting science problems to solve everywhere, and I find it challenging and fascinating to solve those.
The other reason I enjoy this is space weather, and that means, really, that what we're doing here has very practical applications for humankind. Space is not just benign and interesting and nice to look at. If you look at the stars, it also has potentially harmful effects on humans, the equipment and implications for humankind, you know, for humans in space and the astronauts (ph) in space as well as on the ground, and that means that what you're doing as part of your research translates more or less directly into something that's societally relevant, and that is something that the public is greatly excited about, and it's fascinating to not only do basic research, but the basic research that has this kind of value.

DR. HESSE: Well, in many ways, this started -- for me, this started in the -- maybe the mid-'90s or so, where I was involved in what is referred to as the Geospace Environment Modeling project that was funded by the National Science Foundation, which is looking into generating what they called a Geospace General Circulation Model, which is the equivalent of what you do for the atmosphere, but then for geospace, and it was realized as part of this that the creation of such a model would have implications also for the space environment or with utility for space environment specification and forecasting. Everything was in its infancy at that time.
At the same time, it was also realized that for such a model to exist and have a maximum benefit, it would be extremely useful to have a facility which would host such a model or such models and make those available for the science community, evaluate those models, and test them and perhaps facilitate their transition into space weather forecasting.
And that facility was created here at Goddard. It turned out to be the Community Coordinated Modeling Center, and I was the founding director of that activity. It was officially inaugurated in 2000, but the work that led to it began much earlier, in the '90s, you know, in various community activities where this concept was discussed and evolved and preparatory negotiations between the DoD, NSF and NASA, and other agencies took place. So there was a lot of work being done in preparation of that and emerged out of the GEM program in many ways, but then grew to encompass much more.
And this facility was then created with the objective to do exactly what I said earlier, not only to serve scientists across the world, but also to explore models insofar as they are capable to aid in space weather forecasting. And that has been the guiding principle.
And that's really how I got into space weather, coming from the basic science side, was an interagency consortium that had a number of agencies on them. Some of them were in the -- on the science side, like NASA and NSF, and some of them were on the space weather side, like the Air Force and NOAA, and it was a very pleasant interaction at the beginning, where we all worked together to see how we can get the maximum benefit out of this -- out of what comes from the research side and this new activity to essentially support space weather modeling. Yeah.
So that's how I got into that. My role, then -- you know, I've been the director of this until two years ago, so it evolved from the inception of the program to essentially participate in research activities of staff, evaluating models under different conditions, you know, to guiding the overall activity to now include space weather forecasting for NASA. Here, my division and attachment of the CCMC, the Space Weather Research Center, is now the dedicated space weather provider for NASA. There's continued and much expanded testing of models and evaluations with the

scientific community. They are support for the -- great support for the DoD model evaluations for NOAA, and so now they're going on a routine basis.
I participated in many of those directly or indirectly, as leading the activity, during that time, and now I'm supporting it from the division director level.

DR. HESSE: I mean, I think initially, in the '90s, we weren't quite as advanced in our recognition how far our technological systems are susceptible to space weather. I think that recognition grew as a function of time, kind of along with a growth of our capabilities to address those; not to say that we don't have much more to do there, but, you know, we've learned to do much better than we did at that time.
But I think it's fair enough to say that initially, the push to do this came from the science community rather than from the operational community. There was a much stronger push in the science community in recognition that this could be turned into something useful for space weather than it was in the operational community.
At the time, the -- what is now called the Space Weather Workshop, the annual event, was actually -- grew out of something that one of the leaders of the GEM program, George Cisco, created, a workshop that brought together potentially interested customers in space weather together with scientists and modelers to see what their needs were and whether models could be evolved. That is, unfortunately, not very often recognized, but it was George Cisco who had this vision and actually carried it forward. You know, and that then evolved into something that was then later picked up by NOAA, but initially, it was this -- basically came from the science community.
Yeah, so that tells you that at that time, at least as far as I can see, the societal relevance was not nearly as much accepted as it is now. You know, as the interaction between potential customers and scientists and operators and so on grew, more and more information flew across those boundaries, and much more became known.
So in the early '90s, when the GEM program was created, I think there were very few people who had the vision that it could lead -- that this model development activity could lead to the value that now everybody believes it has. Now we are in a completely different world there. I mean, as (inaudible) are seen in the metrological world, you know, as your capabilities grow, people would start to understand, you know, you can use that for things that you didn't really realize that you would have any means of dealing with. Yeah?
So, no, you're right with your question. I think at that time, we were much less aware of how important space weather is than we are now.

DR. HESSE: Well, I mean, I think the key -- I mean, the key event was the inception of the GEM program. I mean, this really, from a development and scientific point of view, was breaking completely new ground. You know, it was then later followed by the SEDA (ph) and (inaudible) programs, which develop similar forci (ph), you know, but the GEM program, with its key focus on developing modeling capabilities, was really perhaps the major steppingstone in terms of developing capabilities that existed.
Then an avalanche of further activities followed, you know, modeling programs, like -- or support programs like the Targeted Research and Technology program, which really infused major money into this, then took this potential and provided the foundation to actually turn that into more and more products.
But the recognition, the idea, you know, to do this, that it could be done, originated in the GEM program, and that is often forgotten, and it cannot be said often enough. And, again, the person to credit with that is George Cisco.
NASA, you know, with Dick Fisher coming into -- getting to headquarters and being supportive of space weather research with the Targeted Research and Technology program, stepped up to the plate and joined -- not only joined NSF in supporting it, but provided a major amount of financial support to researchers to develop that, and that program has and continues to make a substantial difference in our capabilities.
You know, from -- but I'm only talking about models. You know, what we really need to look for is data. You know, you can model anything you want if you don't have the data resources. And there, from a forecasting point of view, you know, we still couldn't really forecast any impact of solar eruptions if we weren't observing the sun, and perhaps the most important of all assets ever developed is SOHO, you know, as you know, a joint ESA/NASA mission that is still operating and hopefully will continue to do so for a while.
You know, additional major steppingstones are the STEREO spacecraft, which let us, for the first time ever, look at coronal mass ejections stereoscopically and therefore provide much higher accuracy in giving inputs to models to then predict their continuation of evolution, you know.
I mean, the ACE spacecraft that lets us monitor the impact near the Earth, and so without which, we would have no clue what is actually arriving at the magnetosphere, you know. Basically, the fleet of primarily NASA spacecraft, actually -- not to forget those, of course -- and POES and the DMSP spacecraft from the DoD side, I mean, that

really -- from a data point of view -- you know, from ground truth as well as driving models, is invaluable -- has been invaluable for space weather.

So if you want to look at key, you know, times after which things change, you can look at the launch dates of those missions. I mean, that's basically when this new capability became available, and then, you know, will continue to be available for a while.

DR. HESSE: Well, in research -- I mean, there's two questions, really. One is how do we provide data continuity or evolve data continuity if you want, and the other one is how do we -- which research questions are there, and how do we address them?

And I would maintain that unlike terrestrial weather, where we have a very solid physical understanding, physical and chemical understanding of the basic processes that determine weather, we are not nearly there in space weather. There are many fundamental problems that we simply don't understand. You know, we're making -- of course, making progress on our understanding how particles are accelerated, which is a key phenomenon in the magnetosphere and the radiation belts, you know, with the Van Allen probes.

But, you know, one of the key questions, we basically still don't have any clue competing theories, but which one is right is how energetic particles in the solar atmosphere get accelerated; you know, solar energetic particles that are a major hazard, you know. We cannot -- we don't understand how coronal mass ejection is being created and ejected. That theories, competing theories, we are currently unable to resolve those, and maybe there's more than one solution. So, I mean, these are just examples of basic scientific questions that one would have to understand if we want to do reliable prediction of space weather. So space weather is, unlike terrestrial weather, a research activity; first and foremost, a research activity. That is, again, some -- the name, in many ways, is a misnomer, because it suggests something that really isn't there, that space weather is like terrestrial weather, you know, where, okay, we find things and make them better and better. Here, we are at ground zero in many cases. You know, we don't have the answer. We don't have the basic fundamental answer. So much research is needed in order to further space weather. If we quit that now, you know, we're stuck in the Stone Age, relatively speaking.

Now, the other thing is data continuity, you know. For research as well as for operational purposes, we need data continuity, and there's pretty much, as the present time, no plan on how to do that. There's no plan. We have these existing assets that we use. You know, none of them are -- with the exception of GOES and POES and DSMP and so on, most of them are not what anyone would call operational or designed to provide continuity ad infinitum, and we currently have no plan on how to continue that, but we need to. We need to find a way to do that. If the country takes it seriously, we'll have to find a way to do it.

DR. HESSE: I don't want to speculate here what the answer is to that, but it is an outstanding problem that we need to solve, and we're going to have to -- in order to forecast, we're going to have to do it, and also in order to answer many of the science questions that are still outstanding, we need that information. And so we're going to have to deal with that, and how that's going to be dealt with is something to be determined, but I'm optimistic that we will find a way to do it.